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THE

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OF THE

HOUSE OF REPRESENTATIVES

FOR THE

FIRST SESSION OF THE FIFTY-FIRST CONGRESS.

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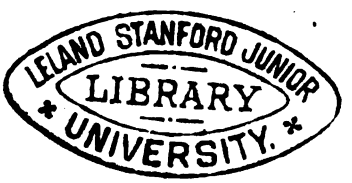

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TWO HOUSES OF CONGRESS

AT THE

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B. M. HARROD,
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UNITED STATES ARMY.

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REPORT OF MAJOR O. H. ERNST, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

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3. Trinity River, Texas.
4. Buffalo Bayou, Texas.
5. Mouth of Brazos River, Texas.
6. Pass Cavallo Inlet to Matagorda Bay, Texas.
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UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 7, 1889.

SIR: I have the honor to transmit herewith the annual reports for the works under my charge for the fiscal year ending June 30, 1889.

* * * * * * *

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

V 1.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

A plan of the works designed to improve this entrance is shown upon the accompanying map. At the date of my last annual report the work of reconstructing the old south jetty was in progress. Beginning at the point B, the jetty had been built up to a height of 5 feet above mean

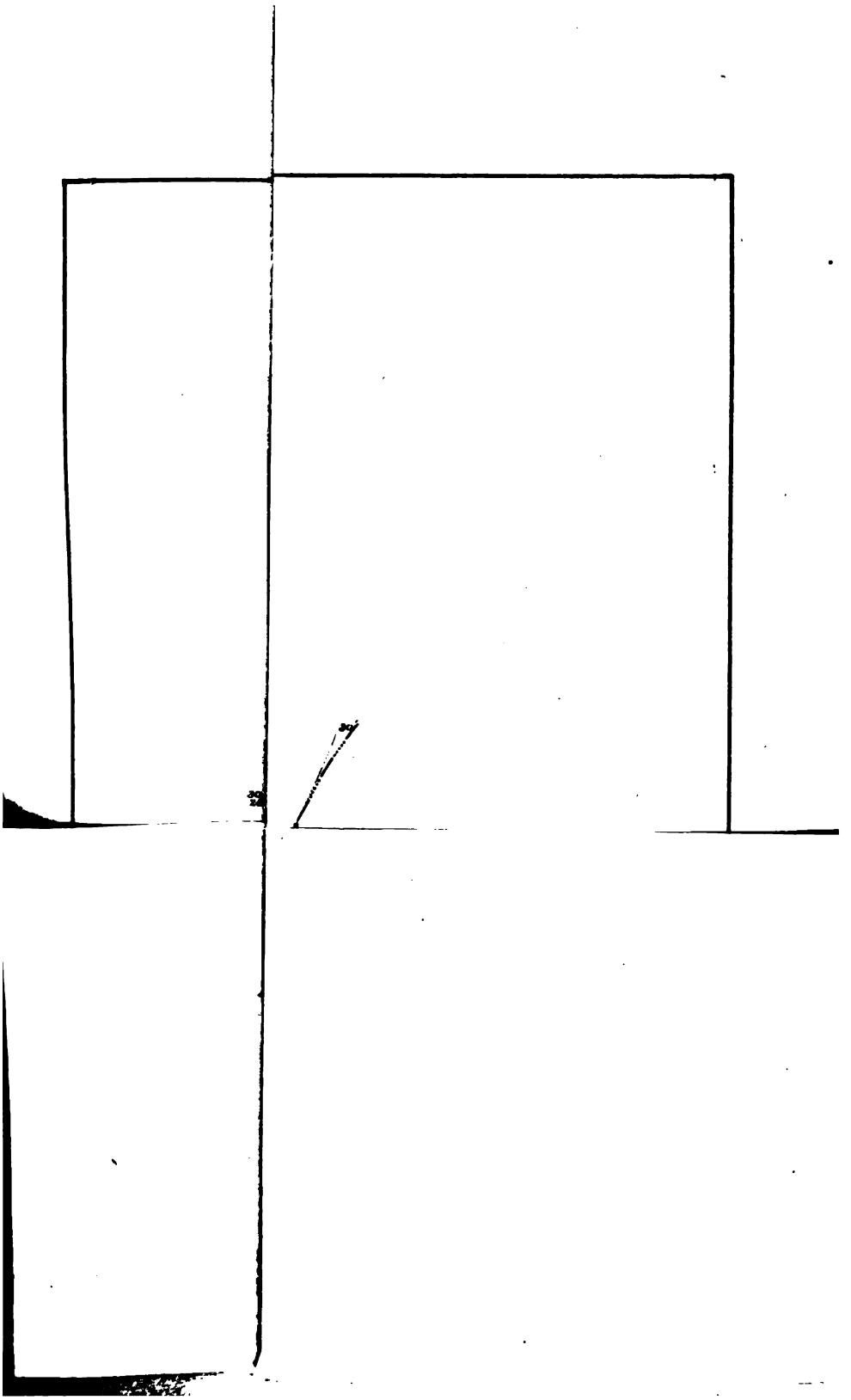
low tide to a distance 4,550 feet seaward. It had also been connected with the shore at A by a wall of ordinary riprap 1,100 feet long, sloping gradually downward to the level of the ground, which at A was about 6 inches above mean low tide.

The work of extending the jetty seaward was continued until July 17, when it was suspended for want of funds. Additional funds having been provided in the river and harbor act of August 11, 1888, work was resumed October 15, 1888, under a new contract dated October 13, 1888, with A. M. Shannon & Co. During the year a shore branch A′ A 8 464 feet long was constructed to connect the former work with the relatively high ground upon which Galveston is built. It was not entirely finished. The object of this work is twofold, viz, to furnish a secure anchoring point for the south jetty, and also to improve the Galveston Channel. The jetty was also extended seaward a distance of about 900 feet which was finished, and about 200 feet more which was not finished. The trestle and railway, by means of which the material is carried to its place, was built to a distance of 2,175 feet in advance of the unfinished work. The total length of jetty now constructed is 15,200 feet, of which 9,564 feet is in the shore branch and the remaining 5,636 feet is seaward of the point B. Over much of this distance it is not entirely finished, but it constitutes for most of the distance quite an effective barrier to the flow of water. The total length of the railway upon the crest of the jetty, including that built upon the trestle in advance of the stonework, is 17,375 feet.

By the terms of the contract it was to have been completed on or before June 30, 1889, but at that time it was only about two-fifths done. The time has been extended to December 31, 1889, all additional expense caused to the United States by the extension to be deducted from the sums due or to become due the contractors. It is expected that a further gulfward extension of about 1 mile will be made under this contract.

A resurvey of the entrance was made in May and June, from which the accompanying map has been constructed. The contours of 1888 have also been placed upon the map, by means of which a comparison between the surveys of 1888 and 1889 can be made and the changes noted which have occurred during the year. The effect of the new work is perceptible. The channel depth upon the outer bar is found to be 13¼ feet, and that upon the inner bar 21 feet, both at mean low tide, which are in both cases an increase of 6 inches during the year. The distance across the outer bar from 24 feet inside to 24 feet outside has diminished from 14,100 feet to 13,500 feet, a difference of 600 feet, or about 4 per cent. The distance from 18 feet inside to 18 feet outside has diminished from 7,180 feet to 6,340 feet, a difference of 840 feet, or nearly 12 per cent. There has been no important change in the outer face of the bar. There has been some advance of the 30-foot curve, but the 24-foot and 18-foot curves are almost identical with those of last year. The old mattress jetty has continued to deteriorate. The average depth over the outer 5,000 feet of it is 10 feet, which is a further subsidence of 1.74 feet during the year. Nearer shore there has been little or no further subsidence.

The record of the self-registering gauge kept at the Government wharf shows that the level of mean low tide during the past year has been about 5 inches higher than the level fixed for that plane in 1872, which level has been used in all official reports. Consequently the depth available for vessels crossing the bar has been 5 inches greater than the depth referred to in the old plane of reference. Upon this basis the



depth at mean low tide is now 13 feet 8 inches instead of 13 feet 3 inches as herein reported. The use of the old plane is continued, however, because further observation is required to demonstrate that the last year is not an exceptional one, and also to avoid confusion in making comparisons.

The work was under the immediate supervision of Mr. H. C. Ripley, assistant engineer. His report, to which attention is invited for details, is hereto appended.

The tidal observations in Galveston Bay, inaugurated last year, have been continued. They have developed many interesting facts, and among others the necessity of placing additional gauges at points intermediate to those heretofore occupied. It is proposed to continue the record at all the places reported last year as occupied, and to place additional gauges, one on the north side of Redfish Bar, one on the south side, and one at Hanna's Reef. These observations have been under the immediate supervision of Lieutenant Langfitt. His progress report, to which attention is invited for a discussion of the information thus far collected, is hereto appended.

The amount recommended for appropriation for the fiscal year ending June 30, 1891, is $2,350,000, of which $850,000 is the amount required to finish the south jetty to the crest of the bar, and $1,500,000 to build the north jetty to the same distance.

The original estimated cost of this work as revised in 1886, is	$8,478,000.00
The aggregate amount appropriated to July 1, 1889, is	2,278,000.00
The amount expended, including outstanding liabilities, is	1,967,176.27

In addition to this there was expended the sum of $100,000 subscribed by the city of Galveston in 1883.

The work is located in the collection district of Galveston. The nearest light-houses are at Bolivar Point and Fort Point, at entrance to Galveston Bay.

The amount of revenue collected at the Port of Galveston for the fiscal year ending June 30, 1889, was $153,049.51.

Money statement.

July 1, 1889, amount available		$2,871.13
Amount appropriated by act of August 11, 1888		500,000.00
		502,871.13
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$183,310.96	
July 1, 1889, outstanding liabilities	8,736.44	
July 1, 1889, amount covered by existing contracts	272,060.27	
		464,107.67
July 1, 1889, balance available		38,763.46

Amount (estimated) required for completion of existing project	6,200,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	2,350,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for building a jetty at the entrance to Galveston Harbor, Texas, received in response to advertisement dated August 21, 1888, and opened September 20, 1888, by Maj. O. H. Ernst, Corps of Engineers, at Galveston, Tex.

No.	Name and address of bidder.	Riprap, 105,000 cubic yards.	Blocks stone ½ to 2 ton each, 8,000 cubic yards.	Blocks stone 2 to 5 ton each, 23,000 cubic yards.	Railway, 13,500 linear feet.	Rails, 6,900 linear feet.	Amount.
		*Pr. cu. yd.**	*Pr. cu. yd.*	*Pr. cu. yd.*	*Pr. ft.*	*Pr. ft.*	
1	A. M. Shannon & Co., Galveston, Tex.....	$2.08	$4.30	$4.30	$3.25	$1.00	$402,475
2	G. W. Burkett, Palestine, and T. C. Stribling, Brenham, Tex..	2.60	4.40	4.50	3.80	.80	468,520
3	Louisiana Jetty and Lighting Company, New Orleans, La....	2.55	4.33	4.33	3.10	.70	448,660
4	Ricker, Lee & Co., Galveston, Tex.....	2.06	3.43	4.12	*20.97	*7.31	807,034
5	Samuel W. Swift, Galveston, Tex.....	2.21	3.85	4.25	3.50	1.00	414,750

*After bids were opened Messrs. Ricker, Lee & Co. stated that their figures for railway and rails were clerical errors, and should have read $3.00 per foot for railway and 73 cents per foot for rails.

No. 1, lowest; acceptance recommended.

REPORT OF FIRST LIEUTENANT WILLIAM C. LANGFITT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 1, 1889.

SIR: I have the honor to submit the following progress report on the subject of the tides and tidal records of Galveston Bay.

I was placed in charge of these records about the middle of October, 1888. At this time the plotted records were about four months behind the rolls as taken from the tide gauges. After familiarizing myself with the mode of plotting and the necessary data, my first efforts were directed to bringing them up to date.

Other duties have interrupted the plotting and study of the records, among which may be mentioned the survey and examination of the bank of the Rio Grande River in the vicinity of Fort Brown, Tex., in November and December, 1888, and the survey of Galveston Harbor and Entrance in May and June, 1889. There was also a delay of a month in the arrival of the lithograph sheets upon which the records are reduced during which no plotting could be done.

All of the gauges have been visited by me at least once and some of them oftener. I regard it as very desirable that they should be visited at least once every month, and oftener, if practicable, to insure that they are working properly, and that the clocks are set correctly. Hence it is to be regretted that some means of communication with the distant gauges is not in possession of this office.

Owing to the experience gained during the preceding year, the records as a whole have been more satisfactory. The defect in the "fixed pencil holder," mentioned by Lieutenant Zinn in his report of last year, has been corrected by the substitution of a new one on each gauge. They are so constructed that by placing small weights on them any desired constant pressure of the pencil on the paper can be obtained. A little care thus gives a uniform distinct line.

The manner of plotting the records has been described in the report of Lieutenant Zinn mentioned above.

About the middle of October, 1888, finding that the gauge at the Government wharf was not working properly, I had the float tube, which was of cast-iron, 4 inches in diameter, raised. It was found to be so badly eaten by galvanic action as to be unfit for further use, and I decided to replace it by a wooden coppered tube of about 6 inches by 6 inches inside dimensions, which were suited to another larger float then on hand, the increase in diameter being advantageous. The float was attached to a brass ribbon which wound or unwound from the slotted rim of a wheel. It is evident that as the ribbon wound or unwound the diameter of the wheel changed, thus giving a constantly changing scale of heights, not indicated in any manner on the paper roll. Hence if these were plotted on the uniform scale of one-half inch to the foot an error would be introduced. Upon investigation this error was found to be about 8 per cent. of the total height, that is, in a tide of, say, 5 feet rise the plotted

record would show only 4.6 feet. As there was in the office another instrument of a scale of 1 inch to the foot, and without this defect, it was placed in order and then set up in place of the old one.

The gauges now in use are all of the same scale of 1 inch to the foot and hour, except the bar gauge, whose scale is one-tenth of a foot to a foot rise.

The bar gauge until September, 1888, had a pendulum clock. The clock was frequently stopped by vibrations of the tide-gauge building, this causing much loss of record. During September the clock was removed and altered to a spring-balance one, under the direction of Mr. H. C. Ripley, assistant engineer. The gauge was not put in working order again until early in February, 1889, since which time a great improvement has been shown and much good tidal record obtained.

In plotting these records it became desirable to see whether the zero of the staff gauge had not changed its position. A comparison with the Government Wharf record, made in the usual manner, showed that the zero line of all records plotted during 1888 should be lowered nine one-hundredths of a foot.

This method of deducing the reading of the zero of one gauge at mean low tide of another is not satisfactory when the gauges are so far apart. As it is proposed during the ensuing year to connect all the gauges by a line of precise levels, this fact will then be obtained independently of such comparisons and enable all observations to be reduced to the plane of mean low tide of any desired location.

The records so far accumulated are of insufficient extent for a proper determination of the tidal movements. There are especially lacking observations on the velocities and directions of the tidal currents at the entrance and throughout the bay. The gauge on the bar has an apparatus attached, designed by Mr. Ripley, assistant engineer, intended to show the direction and velocities of the currents at that point. It is hoped that when the records from it are satisfactory and sufficiently extended some light may be thrown upon this subject.

I have devoted some time to the study of the records, the results of which are given below. The record for the bar gauge extends from April, 1888, to September, 1888, and is much broken. For the other gauges the records extend from May, 1887, to December 31, 1888, but they are also very incomplete. It may be well to state that during the three or four days when the moon has her greatest declination there is developed but one tide per day; for the same length of time near the nodes there are developed two tides of much smaller fluctuation. These are called, respectively, the great declination and small declination tides. The tides connecting these I have called the intermediate declination tides.

In the following table is given the reference of the plane of mean low tide at each gauge to the plane of mean low tide to Galveston, as previously determined; also the rise and fall of the tide at the gauges, for the tides of the moon's greatest declination, least declination, the intermediate tides, and mean of all tides:

TABLE I.—*Rise and fall of tide.*

Location of gauge.	Plane of M. L. T. above established plane of M. L. T. at Government Wharf.	G. D. T.	S. D. T.	I. D. T.	M. T.
		Feet.	*Feet.*	*Feet.*	*Feet.*
Bar	+0.295	2.37	1.19	1.67	1.60
Government Wharf	+0.42	1.53	0.63	1.206	1.034
Rollover	+0.28	1.34	0.79	1.11	1.04
Morgan's Point	+0.58	0.82	0.45	0.69	0.61
Round Point	+0.52	0.77	0.45	0.71	0.65

The above table presents several facts of peculiar interest. The first is the apparent elevation of the plane of mean low tide at Government Wharf. This amount (0'.42) is far beyond the limits of any error that may have been made in determining it. The plotted records and the rolls as they came from the gauges have been examined, but no error found in them. An examination of the wind record during the period of high low waters may throw some light on the subject. A redetermination of the zero of the staff gauge of the Government Wharf, compared to the B. M. on the Hendley building, was made, but it was found to be practically unchanged. This bench-mark reads 6.879 above the M. L. tide as established from the observation of 1872-'73.

The second is the fact that the plane of mean low tide at Rollover is, for the period embraced, 0'.14 lower than the plane of mean low tide at Galveston, and that the mean fluctuation at that point is slightly greater than at Government Wharf. Roll-

over is, approximately, 30 miles from the bar gauge at the bottom of a shallow bay obstructed by a reef across its entrance, while Government Wharf is only 6½ miles. These results were therefore entirely unexpected. The shape of East Bay, in which Rollover is situated, may possibly affect the fluctuation, as it is of funnel shape.

It will be noticed also that at all of the gauges the plane of mean low tide is above that assumed at Galveston. The amount at the bar (0'.29) may perhaps be partially accounted for by the imperfect comparison of the gauges. The amount of the elevation at Round Point, and at Morgan's Point, is larger than expected. Whether in the future the plane of mean low tide at Government Wharf will fall to what it has heretofore been assumed, and whether also the planes at the other places will be lowered proportionally, can only be determined by future observations.

A partial determination of the delay in time of high and low water referred to the bar gauge, is given in the following table, together with their approximate distance from that point:

TABLE II.—*Delay in high and low water from the bar gauge.*

Location of gauge	Distance from bar.	Delay in hours.	
		High water.	Low water.
	Miles.		
Government wharf	6.25	1.43	1.49
Rollover	30.	4.8	5.8
Morgan's Point	30.75	7.1	6.2
Round Point	35.50	7.9	6.8

The amounts of these delays in the cases of the last three gauges has raised the question whether the upper bay above Red Fish Bar, and East Bay back of Hannah's Reef, added materially to the effective tidal flow back and forth over the bar. The solution of this question is important, and to help determine it three new gauges have been ordered, one of which will probably be placed near to and above Red Fish Bar. A second will be placed near to and below the same bar, while the third will be placed near to Hannah's Reef. These gauges have been received and are in operation on the Government Wharf for the purpose of testing and adjusting them before putting them up in their permanent place. The records of these gauges, it is thought, will throw much light on this question and the one at Hannah's Reef may help to explain the unexpectedly large fluctuation at Rollover. It may be of interest to state in this connection that during a "norther" on January 28, 1889, the tide just above Red Fish Bar at the light-house read 1.3 feet, and at Halfmoon light-house the same tide read 3.1 feet below mean low tide, both being at their lowest. Red Fish Bar is 17 miles from bar gauge, while Halfmoon light-house is 10. These figures were obtained from Mr. Hartwick, United States assistant engineer in charge of the Ship Channel Improvement. This same tide read at—

Government Wharf, 3.65 below mean low tide.

Rollover, 0.80 below mean low tide.

Morgan's Point, 0.65 below mean low tide.

Round Point, 0.80 below mean low tide.

The above facts illustrate the great obstructions caused by Red Fish Bar and Hannah's Reef to the tidal flow.

In the following table are given the average values of the following quantities for the Government Wharf and bar gauges deduced from the same records as Table I, viz: The mean fluctuation, the time to rise .5 of a foot, the time to high water, the time to fall .5 of a foot, time to low water, for the tides when the moon's declination is greatest and least, and for the intermediate tides and the mean of all tides:

TABLE III.

	At bar.					At Government wharf.				
	Mean rise and fall.	Rise to .5 foot.	Rise to high water.	Fall to .5 foot.	Fall to low water.	Mean rise and fall.	Rise to .5 foot.	Rise to high water.	Fall to .5 foot.	Fall to low water.
		Hours.	*Hours.*	*Hours.*	*Hours.*		*Hours.*	*Hours.*	*Hours.*	*Hours.*
G. D. T.	2.37	2.2	7.9	4.1	16.6	1.53	2.98	8.18	9.31	16.52
S. D. T.	1.19	2.4	5.7	2.7	5.9	0.63	3.91	5.93	4.17	6.20
I. D. T.	1.67	2.5	6.4	3.3	9.4	1.206	3.31	7.90	9.68	16.59
M. T.	1.60	2.4*	6.4	3.3	9.44	1.934	3.44	7.30	7.53	11.79

The quantities given in the third and fifth columns include the time at stand or slack. In a great majority of cases this is small, especially on the bar, and can not be evaluated with accuracy from the plotted records.

In this table there will be noticed a great disparity between the time it takes the tide to rise .5 of a foot and that taken to fall the same amount. While this ratio might be slightly reduced by the determination of the high and low water stands, it would still remain very large. This, I think, arises from the fact that the water on the bar rises very rapidly to its highest point and then begins to fall, not from an ebb current but from the water flowing up the bay, the ebb current not setting up until the tide has fallen very considerably. An examination of such current observations as has been obtained from the bar gauge confirms these conclusions.

It will be further noticed that the mean of all the tides on the bar gives a much shorter tide than at Government Wharf. This arises from the fact that on the bar there is developed a second tide during the transition from the single great declination tide to the two small declination tides before this is done at the Government Wharf. This peculiarity is also noticed at Rollover.

It has been assumed (Report of Board of Engineers of January 21, 1886, on Galveston Entrance, Report of Chief of Engineers for 1886, II, p. 1301) that, because at Bolivar the tides rise to high water in 8.9 hours and only fall .5 foot in 9.2 hours (the table above for Government Wharf gives 8.18 and 9.31 hours, respectively) that the great declination tides in the interior will be increased in the same or greater ratio over the mean tide. The following are these ratios deduced from the above tables:

TABLE IV.—*Rise of great declination tide divided by rise of mean tide.*

Government Wharf	1.478	Morgan's Point	1.344
Rollover	1.288	Round Point	1.183

Now, if we take the ratio of the mean tides to the small declination tides for the same points we get the following results:

TABLE V.—*Rise of small declination tide divided by rise of mean tide.*

Government Wharf	.609	Morgan's Point	.737
Rollover	.759	Round Point	.692

A consideration of these two tables shows that the great declination tides are not increased in the same ratio above the mean tide as we go up the bay, but that this ratio apparently approaches unity by a decreasing series; further, the small declination tides show a smaller proportionate decrease as we go up the bay, the ratios increasing towards unity. In other words, the great declination tides suffer a greater reduction proportionately than the smaller ones.

This result seems confirmed by the fact that the delay in high water is greater during great declination tides than it is during small declination tides, as shown by the following table, bar time of high water being taken as the origin:

TABLE VI.

Location.	Delay low water.		Delay high water.	
	G. D. T.	S. D. T.	G. D. T.	S. D. T.
	Hours.	*Hours.*	*Hours.*	*Hours.*
Government Wharf	1.6	1.4	1.5	1.4
Rollover	6.3	5.4	5.0	4.6
Morgan's Point	6.5	6.0	8.3	6.1
Round Point	7.0	6.5	9.2	6.8

These results probably arise from the fact that during the great declination tides the water is disturbed to greater depths, the velocities of movement greater, and consequently the proportionate effects of the resistances are larger during these tides than during the smaller ones.

The following table gives the mid-level of the water at the various gauges referred to M. L. T. of the Government wharf, for the great declination tides, the small declination tides, intermediate tides, and mean of all tides:

TABLE VII.—*Mid-level of water.*

Location.	G. D. T.	S. D. T.	I. D. T.	Mean of all tides.
	Feet.	*Feet.*	*Feet.*	*Feet.*
Bar	0.775	0.950	0.91	0.912
Government Wharf	0.826	1.015	0.953	0.937
Rollover	0.690	0.875	0.780	0.800
Morgan's Point	0.870	0.905	0.905	0.885
Round Point	0.765	0.935	0.800	0.845

This table was obtained by adding to the reading of the plane of M. L. T. for each kind of tide, its corresponding half fluctuation.

The resulting quantities are so nearly equal that no positive conclusion can be drawn from them, but the mid-level seems practically constant at all the gauges for any one kind of tide, and a trifle higher for the small declination tides than for the larger ones.

This table confirms, I think, by its uniformity, the correctness of the results of Table I, as I see no reason to suppose that the mid-level of the bay should be higher or lower than that of the gulf. Hence if any important error was made in determining the reading of M. L. T. it should show itself here, the other factor, mean fluctuation, being practically the same as heretofore determined.

A mean level could be found by adding the co-ordinate of heights of each tide for every hour and finding the mean. The result would for the great declination tides, on account of their form, be slightly greater than the values above found, while for the same reason the values for the smaller tide would not be affected. Hence it is probable that the mean level of the gulf and bay are nearly if not exactly equal. This result arises from the fact that the plane of M. L. T. rises during small declination tides very much above what it is for the great declination tides, as shown in the following table:

TABLE VIII.—*Plane of M. L. T. for the G. D. T. and S. D. T. and I. D. tides.*

Location.	G. T. D.	S. D. T.	I. D. T.
Bar	−0.32	−0.45	−0.17
Government Wharf	−0.06	−0.70	−0.35
Rollover	−0.02	−0.48	−0.22
Morgan's Point	−0.46	−0.68	−0.56
Round Point	−0.38	−0.71	−0.42

It would seem, therefore, that in passing from G. D. T. to S. D. T. the bay received more water than it passed out, and in passing from S. D. T. to G. D. T. the reverse is the case.

As subsequent reductions are made the values of the quantities in all of the above tables may be changed more or less. They are in fact introduced more to give a general idea of the problems involved and to show the need of more extended observations at a greater number of places than on account of their value in their present unfinished state.

It is to be regretted that lack of time has prevented a more extended study of the tidal movements and the solution of the unexpected elevation of the M. L. T. at Government Wharf over what had heretofore been determined.

Very respectfully, your obedient servant,

WM. C. LANGFITT,
First Lieut. of Engineers.

Major O. H. ERNST,
Corps of Engineers, U. S. A.

REPORT OF MR. H. C. RIPLEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 5, 1889.

MAJOR: I have the honor to make the following report relating to the improvement of Galveston Harbor, Texas, for the fiscal year ending June 30, 1889:

JETTY CONSTRUCTION.

At the end of the last fiscal year the work under contract with A. M. Shannon & Co. *for building* a jetty was incomplete. The work was therefore continued by

July 15, 1888, when their contract expired. After the expiration of their contract the work was continued as extra work, but at contract prices, until July 17, when, on account of the exhaustion of the appropriation, the work was suspended.

On September 20, 1888, bids were opened for a continuation of the work under a new appropriation, and the contract was again awarded to A. M. Shannon & Co.

The specifications require that the stone to be furnished shall consist of large-sized riprap of random sizes, but at least 75 per cent. of it must be in pieces weighing from 250 to 1,500 pounds, of blocks weighing not less than three-fourths of a ton each for the protection of the top and sides on the shore branch, and of blocks weighing not less than 2 tons each for the protection of the top and sides on the gulfward extension. They also require the contractors to build a railroad trestle over the line of the proposed work, to alter the grade of the track over that portion of the jetty already constructed, and to furnish new rails for the same. The changing of grade was to be done at cost price.

Work under this contract was commenced October 15, 1888, by the commencement of the construction of the railroad trestle for the shore branch. The placing of stone did not commence until the 2d of the following month.

LOCATION OF THE WORK.

The shore branch of the jetty commences at a point on the axis of Avenue A 105 feet west of the west face of Ninth street, and extends as follows:

From O (sta. zero) to P, on a tangent whose bearing is 73° 17′, 105 feet; from P to Q, on a curve whose radius is 835 feet, 625 feet; from Q to R, on a tangent whose bearing is 30° 24′, 1,040 feet; from R to S, on a curve whose radius is 1,965 feet, 750½ feet; from S to T, on a tangent whose bearing is 8° 37′ 28″, 5,500½ feet; from T to U, on a compound curve whose radii are 1,000 feet and 1,200 feet, 380½ feet; from U to V, on a tangent whose bearing is 30° 53′ 54″, 950$\frac{4}{10}$ feet; from V to W, on a curve whose radius is 560 feet, 368$\frac{8}{10}$ feet; from W to station 13 (of last year's work), on a tangent whose bearing is 68° 47′, 43$\frac{7}{10}$ feet. At W the line coincides with the axis of the old work, and in the gulf extension of the new work the axis coincides with that of the axis of the old mattress jetty, except on the curves where it was necessary to make a deviation to avoid an angle. The line of the work has been measured and marked at an interval of 100 feet, designated as stations. The old work has been renumbered, to correspond with the new, so that all distances given either on the new or old work refer to the zero of the shore branch. The difference between the new and old numbers is 84+64′, so that station 11 (old No.), which is the inner end of last year's completed work and the outer end of the shore branch, is, according to the new numbering, station 95+64′.

AMOUNT OF STONE USED.

The following table (No. 1) shows the number of cars and amount of each kind of stone placed during each month throughout the year.

TABLE 1.—*Showing kind and amount of stone used.*

Month.	Cars.	Riprap.	Cars.	Blocks.	Total cars.
		Cu. yds.		*Cu. yds.*	
July	276	4,598.76	131	1,146.30	407
August					
September					
October					
November	191	3,656.77	1	9.66	192
December	382	7,788.00	67	739.65	449
January	393	7,308.40	194	1,899.87	587
February	593	10,860.52	301	2,823.89	894
March	468	8,238.16	378	3,181.54	846
April	187	3,147.60	177	1,542.11	364
May	135	2,158.47	148	1,347.56	283
June	100	1,692.23	107	1,027.26	207
Total	2,725	49,448.91	1,504	13,717.84	4,229

It will thus be seen that the total number of cars of stone placed during the year was 4,229. Of these, 2,725 cars contained 49,448.91 cubic yards of riprap, and 1,504 cars contained 13,717.84 cubic yards of blocks, making a total of 63,166.75 cubic yards of stone placed.

The average amount and cost per car was as follows: During July, for riprap, 16¾ cubic yards and $43.32; for blocks, 8¾ cubic yards and $38.50. Since July, for riprap, 18½ cubic yards and $37.79; for blocks, 9⅛ cubic yards, and $39.37.

METHOD OF CONSTRUCTION.

The method of construction has been similar to that of last year, where stone alone was used, except on the shore branch, where there was little or no water. There the construction of the railroad trestle was followed with a layer of riprap 20 feet wide and 1½ feet or more in thickness, to be afterward raised to full height and covered with blocks. On account of apprehended settlement of this work during construction the greater portion of the shore branch is left without blocks upon the top, so as to permit the height to be restored easily before its completion. In the gulfward extension the riprap is brought up to full height at once and immediately covered with blocks, leaving only so much of the work incomplete as is necessary to work to advantage.

The riprap is deposited from the cars either by hand or with bars, and allowed to take its own side slope until it comes above the surface of the water. It is then brought up to a level grade of the proper height and top width, so that when the blocks are placed the jetty will have a height of 5 feet and top width of 12 feet. The blocks are then deposited from the cars with bars and rolled down the sides until they are completely covered. Above the water surface the blocks are all carefully placed with a derrick, so as to completely protect the interior mass of riprap, and give to the surface as smooth and even an appearance as is practicable with irregular blocks of stone.

CONDITION AND PROGRESS OF THE WORK.

The condition of the work at the end of the year and the progress made were as follows:

The railroad trestle has been completed from station 0 to station 79+58′.55, and from station 144+3′½ to station 173+75′, a distance of 10,930.05 feet.

The railroad over the completed portion of last year's work, and its connection with the shore, has been reconstructed, and the grade changed so as to incorporate the caps in the rock work, and new steel rails have been placed over the same. This work extends from station 79 + 58′.55 to station 144 + 3′½—a distance of 6,444.95 feet.

The rock work has been completed from station 0 to station 9 + 60′, from station 70 + 70′ to station 71 + 15′, and from station 141 + 14′ to station 150—a distance of 1,891 feet.

The rock work is incomplete from station 9 + 60′ to station 70 + 70′, from station 71 + 15′ to station 95 + 64′, and from station 150 to station 152—a distance of 8,759 feet.

That portion of the work designated as incomplete has progressed as follows:

The riprap work has been brought up to full height, ready for the blocks from station 9 + 60′ to station 70 + 70′, from station 71 + 15′ to station 95 + 64′, from station 150 to station 151—a distance of 8,659 feet; and the riprap work is incomplete from station 151 to station 152—a distance of 100 feet. Blocks have been placed on the sides of the work in quantity sufficient to nearly complete the covering from station 9 + 60′ to station 58 + 70′, and from station 74 to station 78—a distance of 5,310 feet.

Blocks have also been placed on the sides and top of the work in quantity sufficient to nearly complete the covering from station 58 + 70′ to station 74—a distance of 1,530 feet.

Blocks have also been deposited on sides, but not placed and in quantity not nearly sufficient to complete the covering from station 78 to station 81 + 50, and from station 150 to 151—a distance of 450 feet.

REPAIRS TO OLD WORK.

Some repairs to the old work have been made at places where undue settlement had occurred along the axis of the work where clay was used, and on the sides where a sliding down of the blocks left the riprap exposed. There have been used, in these repairs, which are still incomplete, 615 cubic yards of blocks, and it is estimated that 190 cubic yards additional will be required to complete the repairs, and some of that already used requires placing with the derrick to make the work complete.

COST OF THE WORK.

The following table (No. 2) shows the quantities of stone used and the cost of the same in the work and other items of expense, not including office and inspection expenses. Where the work overlaps that of last year, or where repair is done, to get

the total there must be added the cost of last year's work over the same section. In doing this, however, the difference in the old and new numbers must be considered (84 + 64', added to the old number, gives the corresponding new number in every case).

TABLE No. 2.—*Showing quantities of stone used and cost of the same in the work, and other items of expense, not including office and inspection expenses.*

Items.	0 to 79+64 feet (7,964 feet).				79+64 feet to 84+64 feet (500 feet).			
	Cubic yards.	Cost.	Cubic yards per foot.	Cost per foot.	Cubic yards.	Cost.	Cubic yards per foot.	Cost per foot.
Riprap	23,129	$48,108.63	2.90	$6.04	4,803	$9,990.03	9.61	$19.98
Blocks	9,149	39,340.01	1.25	4.94	66	285.91	.13	.57
Railway	.....	26,077.51	.....	3.27	.....	1,739.82	.....	3.48
Extras	.....	56.07	.....	.01	.....	14.23	.....	.03
Total	32,278	113,582.22	4.05	14.26	4,869	12,029.99	9.74	24.06
Items.	84+64 feet to 95+64 feet (1,100 feet).				95+64 feet to 107+54 feet (1,200 feet).			
Riprap	4,785	9,953.82	4.35	9.05	.....	.....	.....	.....
Blocks	16	70.14	.01	.07	319	1,371.10	.27	1.14
Railway	.....	3,846.93	.....	3.49	.....	4,076.60	.....	3.40
Extras	.....	30.84	.....	.03	.....	28.38	.....	.02
Total	4,801	13,901.73	4.36	12.64	319	5,476.08	.27	4.56
Items.	107+64 feet to 138+64 feet (3,100 feet).				138+64 feet to 141+14 feet (250 feet).			
Riprap	60	155.19	.02	.05	41	107.02	.17	.43
Blocks	296	1,277.92	.09	.41	4	17.60	.02	.07
Railway	.....	10,631.46	.....	3.43	.....	836.90	.....	3.45
Extras	.....	113.94	.....	.04	.....	5.91	.....	.02
Total	356	12,178.51	.11	3.93	45	994.43	.19	3.98
Items.	141+14 feet to 144+12 feet (298 feet).				144+12 feet to 150 (588 feet).			
Riprap	4,496	11,694.57	15.09	39.24	9,624	19,269.78	16.37	32.77
Blocks	1,077	4,738.80	3.61	15.90	2,689	11,564.19	4.57	19.67
Railway	.....	992.95	.....	3.33	.....	2,434.40	.....	4.14
Extras	.....	6.85	.....	.02	.....	37.66	.....	.06
Total	5,575	17,433.17	18.70	58.50	12,313	33,306.03	20.94	56.64
Items.	150 to 152 (200 feet).				152 to 173+75 feet (2,175 feet).			
Riprap	2,508	5,216.93	12.54	26.08	.....	.....	.....	.....
Blocks	101	435.66	.51	2.18	.....	.....	.....	.....
Railway	.....	650.00	.....	3.25	.....	7,068.75	.....	3.25
Extras	.....	6.00	.....	.03	.....	70.11	.....	.03
Total	2,609	6,308.61	13.05	31.54	.....	7,138.86	.....	3.28

It will thus be seen that the average cost per foot of jetty has been as follows: From station 0 to station 79 + 64' (unfinished), $14,26; from station 79 + 64' to station 84 + 64' (zero of old numbers, unfinished), $24.06; from station 84 + 64' to station 95 + 64' (unfinished), $12.64; from station 95 + 64' to station 107 + 64' (repairs), $4.56; from station 107 + 64' to station 138 + 64' (repairs), $3.93; from 138 + 64' to station 141 + 14' (repairs), $3.98; from station 141 + 14' to station 144 + 12', $58.50; from station 144 + 12' to station 150, $56.64; from station 150 to station 152 (unfinished), $31.54, and from station 152 to station 173 + 75' (railway only), $3.28.

SOURCES OF SUPPLY.

The stone used in jetty construction has been brought by rail from three places, as follows:

Riverside, on the line of the International and Great Northern Railroad, 130 miles from Galveston; Clay Station and Quarry Station, on the line of the Gulf, Colorado

and Santa Fé Railway, the former 157 miles and the latter 143 miles from Galveston. The supply came wholly from Riverside and Clay Station until April 27, 1889, since which time it has come wholly from Quarry Station.

SURVEYS.

During July and August, 1888, the survey of the harbor was extended into the bay, so as to include the whole area inside where a depth of 12 feet or more is found. The topography of the adjacent shores was also included in the survey.

The topography embraced the mean high and mean low water shore lines of Pelican Island and of the bay front of Galveston Island, from its connection with the previous survey to a point about 1,000 feet west of Sixtieth street, together with a careful location of the Galveston wharves.

The hydrography embraced an area of about 20 square miles, and covers a portion of the harbor not previously surveyed since 1876, a period of twelve years. Comparing the chart of this survey with that of 1876, it will be seen that considerable shoaling has taken place, especially in that portion of the bay south and southwest of Pelican Island. Over most of this whole area a shoaling of one-half foot to 1½ feet has occurred. West of Bolivar Point there is a loop of the 12-foot contour which has receded 5,000 feet, and a loop of the 18-foot contour which has receded 4,000 feet, and a shoaling of from 2 feet to 7 feet has occurred over an area of an average width of 2,000 feet and length of 9,000 feet. Other slight changes in this vicinity have occurred, but they indicate no important reduction of deep-water areas. The flat areas generally indicate shoaling.

These results are confirmatory of the conclusions reached a year earlier by the results of the ship-channel survey that the bay is surely filling at a very appreciable rate.

During May and June, 1889, a complete survey of the harbor was made, including the outer bar and the inner harbor, to the limit of the 12-foot depth. For want of time only the outer portion of the survey has been plotted. Comparing this with the chart of last year's survey, it will be seen that the depth in the Galveston Channel at its shoalest point just inside of its junction with Bolivar Channel has increased from 20½ to 21 feet, and the width between the 20-foot contours has increased from 190 feet to 300 feet. Upon the crest of the outer bar there has been a pretty general increase in depth of about one-fourth of a foot. The depth in the jetty channel has increased from 12¾ feet to 13¼ feet, an increase of one-half foot. In Bolivar Channel there has been a very perceptible advance of the contours, from the 24-foot contour to the 12-foot contour, and an appreciable increase in the area embraced by the 30-foot contour near its outer end, although there has been no advance of the 30-foot depth. There has been very little, if any, advance of the bar itself. North of Bolivar Channel there has been a slight increase in the swash channel just at the gorge. The area embraced by the 12-foot contour has increased in length 800 feet and in depth one-fourth of a foot.

South of the jetty along its outer portion, where a deep trench has been maintained since the construction of the mattress jetty, there has been a decided change. This trench has very materially shoaled since last year. The area embraced by the 18-foot contour has decreased in length from 6,000 feet to 2,800 feet, in width from 340 feet to 90 feet, and in depth about 1¼ feet. The shoal south of the jetty embraced by the 3-foot contour has receded or moved shoreward in a northwest direction about 900 feet. The shoal north of the jetty has been depressed and pushed gulfward, the outer end of the 12-foot contour having advanced a distance of about 1,000 feet. These changes indicate an increased outward resultant of force, and may be reasonably attributed to the extension of the jetty work.

The diminution in the trench south of the jetty indicates a weakening of the littoral current at that point, caused by an increased outward current during ebb tide. The development of a slight trench on the north side of the jetty near its outer end indicates an increased flow across the jetty at that point during flood tide. The flood water from the south formerly found admission to the harbor across the jetty near its inner end, which is now built up above the water surface. With the extension of the jetty work the greater will be the flow across the jetty at its outer end during flood tide and the larger will be the trench developed thereby on the north side unless the extension of the shoal on the north side is sufficient to neutralize this result. The ultimate deep-water channel must be developed much further to the north in the prolongation of Bolivar Channel, and any deepening in the present jetty channel must be regarded, I think, as but temporary in its nature.

PROFILE OF SOUTH JETTY.

The profile of the old mattress portion of the south jetty compared with that of one year ago shows a still further subsidence of that work, especially near the outer end. For 5,000 feet from the outer end the average subsidence has been 1.74 feet. For

the next 5,000 feet there has been little or no subsidence, and inside further the change seems to be mainly the shifting of the sand which covers the work in many places from one place to another.

The average depth over the outer 5,000 feet is 10 feet, showing that but little if any more than the foundation of the old work now remains.

SOUTH JETTY CONSTRUCTION.

Plan, profile and cross-sections.—The accompanying tracings show the condition of the new work at the end of the fiscal year in plan, profile, and section. These are given in black ink. The profile and cross-section of last year's work is also shown in red for comparison.

The cross-sections were taken at each station, except over last year's work, where they were taken at points to correspond with the old stations. Above the water surface elevations were determined with the level at intervals of 1 foot. Below the water surface depths were determined by sounding at intervals of 5 feet for a distance of 50 feet from the axis of the jetty, and at intervals of 10 feet beyond from station 80 to station 144. From station 0 to station 80 the sections were all taken with a level, and from station 145 to station 152 depths were determined at intervals of 2½ feet to the edge of the jetty. The soundings and elevations are also shown in the plan. The dates at which these were taken are given. Everything relating to the condition of the work at the end of the fiscal year 1889 is shown in black. Everything relating to the fiscal year 1888 is shown in red. The original bottom and outline of old mattress work is shown in brown. The condition at other dates is shown in other colors with dates attached. The water surface of mean low tide is shown in blue.

From station 84 + 64′ to station 95 + 64′ over that portion of last year's work whose axis does not coincide with that of the present work, the profile of the original bottom is shown by a broken brown line, and the profile of the top as it was in June, 1888, is shown by a broken red line. The full brown line over this same distance shows the profile on the axis of the present work which is partly off and partly on the axis of last year's work. In making an inspection of the profile and cross-sections over the line of last year's work it must be remembered that in the process of reconstructing the railroad considerable changes were made in the surface of the stone work itself. Some high places were cut down and other changes made that makes a comparison of the changes for the year unsatisfactory. After the reconstruction was completed, however, and before any repairs to the rock work were commenced, a profile on the axis of last year's work was taken (shown in green), and any changes which have occurred since that time are the result either of settlement which has depressed the surface, or of repairs which have raised it. From these it appears that settlement of any great amount has occurred at only a few places, as follows: From station 112 to station 114 there has been an average settlement of about 1½ feet, and from station 127 to station 128, an average settlement of about 2 feet. Between stations 119 and 120, for a distance of 36 feet, there has been an average settlement of 2 feet, and an extreme settlement of 3 feet. All of the above are where the core of clay was used. For the balance of the distance on the axis the settlement has been very small and uncertain in amount. It is believed, however, that a small amount of settlement has occurred throughout the entire length of the work; but to determine its amount would require more care than we have heretofore attempted. We have evidence, however, that it has occurred from the fact that in the use of the level where turning points have been taken on large blocks of stone firmly fixed in the jetty slight changes in elevation have been observed from time to time.

An inspection of the cross-sections shows no tendency whatever towards undermining the base of the jetty. In fact there has generally been an accumulation of sand along either side of the jetty, except near the end of the completed work, where the concentration of flow across the old mattress jetty scours a deep trench which afterwards fills as the work advances. The maximum amount of this scour is shown at station 151, where the trench on the north side of the jetty is 27½ feet deep at a distance of 60 feet from the axis of the jetty.

Very respectfully, your obedient servant,

H. C. RIPLEY,
U. S. Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS FOR FISCAL YEAR ENDING JUNE 30, 1889.

[Reported by Charles C. Sweeney, esq., collector of the port.]

CUSTOM-HOUSE, GALVESTON, TEX.,
Collector's Office, July 17, 1889.

Amount of revenue collected	$153,040.51
Number of steam-vessels entered	250
Number of sailing-vessels entered	131
Total	381
Number of steam-vessels cleared	244
Number of sailing-vessels cleared	124
Total	368
Total tonnage of vessels entered ..... tons..	416,468
Total tonnage of vessels cleared ..... do...	403,896

V 2.

IMPROVEMENT OF SHIP-CHANNEL IN GALVESTON BAY, TEXAS.

In my annual report for 1887 was given a description of this work and an account of the operations up to that time, together with a map. The work consists in brief in excavating a channel at least 12 feet deep and 100 feet wide at bottom through Galveston Bay, from Bolivar Channel to Morgan's Cut, a distance of about 18.9 miles, the average depth in the bay being about 8½ feet, with a depth in some places of about 7 feet. This channel is one link in a water-way connecting Houston with the Gulf of Mexico, of which the other links are the works at Morgan's Point, the San Jacinto River, and Buffalo Bayou. The works at Morgan's Point comprise Morgan's Canal and Morgan's Cut. Morgan's Canal is a canal cut through a peninsula called Morgan's Point, and connects the San Jacinto River with Galveston Bay. Morgan's Cut is a prolongation of the canal out into the bay, into which it extends a distance of 5 miles. Both the canal and the cut were excavated by the Buffalo Bayou Ship-Channel Company, a private corporation chartered for the purpose by the State of Texas. The canal, excavated through dry land, is private property. The cut, excavated through the navigable waters of the United States, was also, I suppose, private property, while it carried a greater depth of water than that in Galveston Bay, near by. Whether it is private property now that it has resumed its natural depth is a legal question about which I have no opinion. But clearly there is a distinction between Morgan's Canal and Morgan's Cut. This distinction was very clearly presented to Congress in the report and accompanying map of 1887. It has generally been observed in all the reports since 1877, when the work was projected, though not always with perfect clearness. In looking through the reports I have been unable to find any instance where the term "Morgan's Cut" was used to describe the canal to the exclusion of the cut out into the bay, though in some cases it appears to have included both canal and cut.

The Buffalo Bayou Ship-Channel Company agreed in 1881 to surrender to the United States their work at Morgan's Point, together with their charter and their rights under it, upon the completion by the

Government of the ship-channel in Galveston Bay. The acts appropriating money for the work read "Improving ship-channel in Galveston Bay, Texas, from Morgan's Cut to Bolivar Channel." As it appears that the work thus described will be completed when it extends from Bolivar Channel, where it was begun last year, to the southern extremity of Morgan's Cut, it will be suspended at that point, and the Buffalo Bayou Ship-Channel Company will be called upon to execute their agreement of 1881. It is desirable that this should be done without unnecessary delay, as in the exercise of its rights the company charges toll upon all vessels passing through the canal.

At the date of my last annual report the channel had been excavated to its full dimensions for a distance of 11,770 feet northward from Bolivar Channel and partially excavated for a distance of 6,620 feet farther, and the work was then in progress under contract with George C. Fobes & Co. It was continued throughout the year under the contract then in force, and an additional contract, dated February 2, 1889, made with the same firm under the appropriation contained in the river and harbor act of August 11, 1888. On June 22, the dredges having reached the southern extremity of Morgan's Cut, were hauled off, the contractors supposing that their work was completed. A subsequent survey showed, however, that the last 6,225 feet of the channel was deficient in depth in many places, and the dredges were again placed at work. The total amount excavated during the year was 1,618,220.5 cubic yards measured in the scows. Of this amount 190,686 cubic yards were disallowed on account of excessive dimensions, and 168,468.5 cubic yards have not as yet been accepted on account of deficient dimensions, making 1,259,066 cubic yards accepted and paid for under the contracts. It has resulted in practically completing the original excavation of the channel from Morgan's Cut to Bolivar Channel, a distance of 18.9 miles, though, as before stated, some finishing touches are required at the northern end.

Many of the piles placed last year to mark the channel having been knocked down, they are being replaced by more permanent marks described in Mr. Hartrick's report.

A resurvey of the entire length of the channel was made in June. It shows a marked deterioration of the channel through the lower bay where the greatest length of time has elapsed since the work was done. Considering the portion of the channel, 9.93 miles in length, extending from Bolivar Channel to Redfish Bar, the average length of time which had elapsed since the execution of the work was ten months. The average depth of the bay before excavation was 8.63 feet. The average depth of the channel after excavation was 13.15 feet, making an average depth of excavation of 4.52 feet. The average depth of channel was found in June to be 11.61 feet, which shows an average fill of 1.54 feet, or 34 per cent. in ten months. In my annual report for 1887 I stated that "if the channel between Bolivar Channel and Redfish Bar be maintained at the full depth of 12 feet it will require the removal each year of not less than 30 per cent. of the amount originally excavated." (See Annual Report Chief of Engineers for 1887, page 1420.) These views have been fully confirmed.

In the upper bay the average period which had elapsed since the execution of the work was in June only two months, and no important deterioration was detected by the survey.

Upon the completion of the work to the southern extremity of Morgan's Cut there will remain a balance of about $23,000 available for further work. This sum would be sufficient to extend the completed

channel about one-third the distance through the cut. It remains to be determined whether it should be applied to re-excavating the lower bay, to extending the completed channel into Morgan's Cut, or to excavating a narrow and partial channel entirely through Morgan's Cut, if it be found practicable to do that.

The work was under the immediate supervision of Mr. E. M. Hartrick, assistant engineer. His report, to which attention is invited for details, is hereto appended.

As the canal and cut at Morgan's Point are merely an extension of the ship-channel in Galveston Bay, and an essential part of it, and as it is expected that these works will be transferred to the United States at an early day, it is suggested that the title of the appropriation be altered so as to include them. Morgan's Cut for the greater portion of its length is at present merely a line upon the map, the channel which was excavated here prior to 1877 by the Buffalo Bayou Ship-Channel Company having been obliterated except at its northern extremity near the mouth of Morgan's Canal. The canal has also suffered some deterioration since the survey of 1887. The estimate herewith submitted is intended to cover the cost of excavating the cut as well as the ship-channel proper.

The following remarks in former reports are repeated:

It sometimes happens that a temporary deepening of a channel will be of value to vessels using it, even if it subsequently return to its original condition, because it enables them to load to a deeper draught for a longer or shorter period. Such is not the case here. The design is to create a commerce which does not now exist, that is, to provide a channel for sea-going vessels of deep draught, such as do not now visit Houston or cross the bay at all. The natural depth is sufficient for all vessels which now navigate the bay, loaded to their fullest capacities. No useful result can be obtained from expenditures upon this work until it is completed, and such provision made for its maintenance as will inspire confidence in its permanency as a highway of commerce. Important trade will not follow an uncertain highway. To half finish it or to one-quarter finish it one year and then leave it to be continued at some indefinite time in the future is a waste of money. There should be on hand when the work is begun funds sufficient to carry it through and maintain it at least one year.

The estimate, $200,000, submitted for continuing the work during the year ending June 30, 1889, is the amount required to complete the original excavation and maintain it one year. With this sum, and with regular appropriations thereafter, the work can be carried to a successful completion. With a sum much less than this, or with irregular appropriations thereafter, the work is, in my judgment, entirely impracticable.

No commercial statistics for this work can be given. Some of the best commercial minds in Houston believe that the advantages to be derived from enabling sea-going ships to reach Buffalo Bayou will be vastly greater than the cost of making and maintaining the channel. In the report upon the improvement of Buffalo Bayou herewith are given some statistics of the freight carried upon that stream. It is carried in barges drawing 5 feet when fully loaded, and towed by tugs drawing 7 feet or less. These cross Galveston Bay, but the depth of water is already sufficient to accommodate them. A large proportion of this freight would be loaded directly upon sea-going ships if they visited Houston.

The original estimated cost of this work as revised in 1888 is	$740,108.22
The aggregate amount appropriated to July 1, 1889, is	546,500.00
The amount expended, including outstanding liabilities, is	488,944.24
The amount required for maintenance after the completion of the original excavation is annually	80,000.00

The work is located in the collection district of Galveston. The light-houses on or near the line of the work are at Bolivar Point, Fort Point, Half-Moon Shoal, and Redfish Bar. The amount of revenue collected at the port of Galveston during the *fiscal year* ending June 30, 1889, was $153,040.51.

Money statement.

July 1, 1888, amount available		$7,278.70
Amount appropriated by act of August 11, 1888		100,000.00
		107,278.70
July 1, 1889, amount expended during fiscal year; exclusive of liabilities outstanding July 1, 1888	$48,686.27	
July 1, 1889, outstanding liabilities	1,046.67	
July 1, 1889, amount covered by existing contracts	49,905.71	
		99,638.65
July 1, 1889, balance available		7,640.05
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		200,000.00

Abstract of proposals for improving ship-channel in Galveston Bay, Texas, received in response to advertisement dated November 17, 1888, *and opened December* 17, 1888, *at Galveston, Tex., by Maj. O. H. Ernst, Corps of Engineers.*

[Dredging 700,000 cubic yards, more or less.]

No.	Name and address of bidder.	Per cubic yard.	Amount.
		Cents.	
1	George C. Fobes & Co., Baltimore, Md	12.5	$87,500

Only one bid received. Acceptance recommended.
Amount available for payment under this contract, $101,223.08.

REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

GALVESTON, TEX., *July* 6, 1889.

SIR: I have the honor to submit the following report of operations for improving the ship-channel in Galveston Bay, Texas, for the year ending June 30, 1889:

On the 30th of June, 1888, the ship-channel through Galveston Bay had been completed to its full dimensions, 100 feet wide and 12 feet deep, for a distance from the beginning of 11,770 feet. The contractors were Messrs. George C. Fobes & Co., working under their contract of December 3, 1887; they continued the work under the same contract, being granted an extension of time to January 1, 1889, on their application of June 20, 1888. A second extension was requested on December 20, 1888, and granted to March 1, 1889, and again extended for the third time to March 15, 1889; but the work under the contract of December 3, 1887, was completed on March 10, 1889, when a new contract with the same contractors of February 2, 1889, was begun and continued to June 22, 1889, on which date the contractors removed all the dredges from the work, as they considered they had completed the contract; but on the monthly survey and inspection in June it was found that a 12-foot depth could not be maintained for the last 6,225 feet, so the contractors requested an extension to complete the work.

The dredging plant in July, August, September, October, and November consisted of four dredges, the *C. Fobes, No. 5, Col. Craighill,* and *Gen. Shelly,* with three tenders, the tugs *John Bacon, Col. R. Ingalls, F. C. Fowler,* and *Kate,* one coal sloop, one coal barge, and seven dump-scows of an aggregate capacity of 1,878 cubic yards. Although there were four dredges in the fleet and seven dump-scows, the contractors were only able to keep three dredges and six dump-scows continually at work, as one dredge and one dump-scow was usually undergoing repairs. The *Gen. Shelly* was taken off the work November, 1888, leaving the plant and force for the rest of the contract to consist generally of three dredges, three tugs, six dump-scows, one

coal sloop, four yawls, one superintendent, one carpenter, six captains, six engineers, six cooks, with twenty-six deck-hands, laborers and watchmen.

In order to push the work the contractors in December, 1888, placed a second crew on board two of the dredges and their tenders, the tugs. Day and night work was then inaugurated and continued through January and February, 1889, when the third dredge, which had been undergoing repairs, was again put in commission, and one of the double crews transferred, so that in March and April, 1889, one dredge had a double crew, and two dredges single crews. For the remaining months, May and June, 1889, the three dredges worked single crews, and in the day time.

SYSTEM OF WORKING THE PLANT, MEASUREMENT AND SUPERVISION.

The channel to be excavated is 100 feet wide and 12 feet deep, and is taken out in three cuts, one cut to each dredge from 30 to 40 feet in width, the three dredges being about a mile apart, "echelon" fashion. This was varied in some places, and the dredge allowed to take out a full width as it advanced, thereby saving a little time in moving anchors, and making it possible to place any excessive depth or width on the dredge and captain who did the work. The different cuts are ranged from a row of range piles, set about 100 feet apart on the west bank, and 30 feet from edge of cut. The dump-scows are four-hopper scows, are loaded on the starboard side of the dredge, the dredges facing up the cut towards the north, and moved in that direction, except in Redfish Cut, where the strong current and shoal water on the east bank made it imperative to reverse the dredge and work south, thereby keeping the dump-scows and tug in deep water.

A subinspector was placed on each dredge, and two when on day and night work, to measure and record the amount of material carried away in the dump-scows, see that the scows were dumped at the proper distance from the channel, record all lost time and the cause thereof for each dredge, note the location of each dredge daily as it advanced with respect to the range piles (which are numbered and plotted on working chart in office from sextant angles taken at the time of driving range piles), sound from time to time from stern of dredge and record same to compare with monthly survey, and assist the dredge captain as to the proper move to make for a certain depth, a certain width, and certain bank At the end of each month a survey was made and cross-sections taken of that part of the channel completed to its full dimensions. From this data is calculated the excessive excavation and a deduction made from the measurement as given in dump-scows loaded in that particular part of the complete channel.

The dumping-ground is from five-sixths to 1 mile from the cut, in about 8 feet of water, and as the scows when fully loaded and their tugs draw from 8 to 8½ feet, the work had to be discontinued at very low tides. The dumping-ground was changed from the east to the west side of the channel when within 2 miles of Redfish Reef, as it was thought for the best interest of navigation that no obstruction should be placed to the free beating up and down the bay of schooners making or leaving Middle Pass at Redfish Reef. The dumping-ground for the material excavated in Redfish Cut had to be located in some cases over 2 miles from the place of excavation, as the banks in the immediate vicinity of Redfish Cut had only a few feet of water at mean low tide, and the tugs with scows had to first run a long distance through the cut before they could turn out for their dumping-ground.

The material excavated varied from fine sand, which could not be retained in the hopper without calking and filling crevices with old rope and hay; shell and clay, which clogged the dump-chains so that the doors would not dump, the material having to be removed before the chains could be overhauled and the doors put in working order; hard shell and sand banks, when one quarter of a bucket was considered a good working load for every swing of the bucket; and stiff yellow clay, which in some cases would not dump from the bucket into the hopper and had to be dug out of the bucket. Old trees were not encountered, but an occasional submerged pile and one old wreck, but no delay of any consequence was incurred by snags of any kind.

In the latter part of December, 1888, and all of January, 1889, the fleet was at work in Redfish Cut and approaches, and had to contend against low tides, causing shoal water on the dumping-ground, the tugs and scows remaining hours at a time aground and unable to move. There are in Redfish Cut strong currents, and with bad anchorage it made it impossible to hold the dredges in position at certain times of the tide when re-enforced by strong wind. The material was compact shell, sand, and clay, the bucket coming up only one-fourth full at a time; the material also wedged the dump chains so that they could not dump, and together with the confined nature of the cut, making it difficult to maneuver the tugs and scows. A great loss to the contractors and delay to the work was occasioned from the combined causes named above.

On the survey of Redfish Cut it was apparent that the whole bottom for several hundred feet on each side of the gorge is alive with traveling shell, moving up and down the cut according to the direction of the tide, scouring out and filling up in pro-

portion to the strength and carrying capacity of the current. The nose or point jutting out from the east side of the gorge, which was removed, has reformed south of its old position, and whereas the depth of water over the old point was a few inches at mean low tide it is now above water at mean low tide. The practical effect of taking off this point is to make the current run straighter and with less eddies through the gorge, much to the satisfaction of those using the cut having barges in tow.

The weather was fairly good for most of the year for dredging operations and no unusual damage was done to the fleet. An easterly gale on the 5th of July, 1888, caused the parting of anchor lines. An extraordinary low tide occurred on the 28th of January, 1888, when Redfish gauge in upper bay read 1.3 feet below mean low tide and the Half-moon gauge in lower bay read 3.1 feet below mean low tide; this caused a complete cessation of work.

The gauges would not have shown so great a difference between upper and lower bay only that the San Jacinto and Trinity rivers were in flood and helped to keep upper bay full and above its normal condition when lower bay is empty from continued northers.

For eleven months of the year the schooner *Andrew Boden* was used as a dispatch boat in which the assistant engineers had their quarters, giving personal supervision to the work when not required in the office on records, plotting monthly surveys and cross-sections, etc. The tug *Molyneux* was detailed for a few weeks to make unexpected inspections and assist on a monthly survey, and was found very useful for the purpose.

In the month of June, 1889, the schooner was employed on the erection of beacons that are to mark the channel, and a steam-launch was hired when necessary for inspection until the tug *Molyneux* from Aransas Pass improvement could be available as tender to the schooner on the erection of beacons, inspection boat to the dredge fleet, and survey boat for monthly and annual reports. The *Molyneux* with crew reported for duty on ship-channel improvement the first week in June, 1889, and has been found of great advantage in facilitating the work on surveys.

Tide-gauges were placed on the range piles as the fleet advanced and their mean low tide checked at every monthly survey by the record kept at Half-moon and Redfish Reef. By February, 1889, nearly all the range piles in lower bay had gone, together with south beacon. Various causes contributed to their disappearance, the most important of which was the "Teredo navalis," the life of a green 12-inch pile with the bark on being about two years. Vessels also come in contact with them on dark nights and foggy days, and the dredge fleet in boisterous weather was unable to control anchor lines and tows, and a slight push from any cause overturned or broke the worm-eaten pile.

In February, 1889, specifications with sketch were provided so that contractors and others could bid for the renewal of beacons and range piles, and as the life of a single timber pile in lower bay is about two years it was deemed best to renew all piles marking the channel with material that could resist the ravages of the teredo and be more or less strong to withstand damage from vessels. After canvassing the cost and the adaptability of different materials it was at length decided to use timber piles covered, where the teredo eats, with cast-iron pipe and the annular space between the timber and pile filled with concrete. The beacons were to have four piles. The range beacons were to have three piles formed like a tripod, all surmounted with signal poles and disks. Finding no one familiar with this kind of construction, and the only bids submitted being exorbitant, the Department undertook the erection by day's labor and began work on the 1st of June, 1889, and up to the present time the cost of material and labor expended has been far below any proposal submitted.

FACTS, COMPARATIVE SURVEYS, AND OBSERVATIONS.

The entrance to the channel at Bolivar is to be marked by a beacon and designated as Lower Beacon (L. B.). The southern approach to Redfish is marked by South Beacon (S. B.). The northern approach to Redfish Cut is marked by North Beacon (N. B.). The southern extremity of Morgan's Cut is marked by Morgan's Beacon (M. B.). The distance between L. B. and S. B. is 9.93 miles, "Lower Bay Cut." The distance between S. B. and N. B. is 1.87 miles, "Redfish Cut." The distance between N. B. and M. B. is 7.10 miles, "Upper Bay Cut." Total length of channel is 18.90 miles.

Average depth of bay entrance to channel (L. B.), April, 1888, was 12.3 feet. Immediately after excavation, average 13.52 feet, and maximum 14.6 feet.

Average depth of bay at entrance to channel (L. B.), June, 1889, is 10.9 feet; 14 months after excavation the entrance to channel averages 11.40 and maximum 12.

Minimum depth in channel, time of excavation, between L. B. and S. B., 12 feet; minimum depth in channel, June, 1889, between L. B. and S. B., 10.2 feet.

Average depth in bay near cut, February and March, 1887, 8.56 feet. Average depth in bay near cut, monthly survey, time of excavation, 8.63 feet.

Average depth in channel between L. B. and S. B. at time of excavation, 13.15 feet. Average depth in channel between L. B. and S. B. June, 1889, 11.61 feet. Average fill in an average of ten months' time, 1.54 feet.

The approach to Redfish Cut, south side, scoured out and showed a deeper cut after excavation than was excavated and retains this depth in some places. Redfish Cut proper maintains about the same depth. The width of the gorge remains about the same since the excavation of the point, and the currents set with less eddies through the gorge. The approach to Redfish Cut from the north shows little if any filling, and the same may be said of Upper Bay Cut between N. B. and M. B., the time between monthly and annual survey being too short to detect any appreciable change. Morgan's Cut has shoaled since the survey of 1887.

Morgan's Canal has a decrease in depth since 1887, most probably due from the banks on both sides of the canal sliding into the canal, they not being properly retained and protected.

Currents in Lower Bay near Bolivar set across the axis of channel within 20 to 30 degrees of a right angle. Strong currents are not noticed across the axis of channel in Upper Bay.

SUMMARY.

Total advance of completed channel this year, 78,675 feet, equal to 14.9 miles.

Excavated by each dredge during the year.

	Cubic yards.
C. Fobes	511,295.0
No. 5	686,092.4
Col. Craighill	212,379.6
Gen. Shelly	208,453.5
Total	1,618,220.5
Excavated in advance of completed channel of last year	64,672.9
Total	1,682,893.4

Accounted for as follows:

Allowed contractor this year	1,323,738.9
Deductions this year	190,686.0
Excavated in advance of completed channel for this year	168,468.5
Total	1,682,893.4

Average number of hours by each dredge in twenty-four hours.

Dredge.	Actual dredging.		Repairing machinery.	
	Day work.	Day and night work.	Day work.	Day and night work.
	h. m.	h. m.	h. m.	h. m.
C. Fobes	5 23	7 50	1 19	3 1
Col. Craighill	4 41	None.	1 35	None.
No. 5	6 8	11 41	6 51	1 7
Gen. Shelly	6 39	None.	1 10	None.

The remaining hours were consumed by delays in moving anchors, the repair of dump-scows and changing of same, break down of tugs, meals, boisterous weather, strong currents and low tides, recreation, and sleep.

Very respectfully, your obedient servant,

E. M. HARTRICK,
U. S. Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

CORRESPONDENCE IN MATTER OF TRANSFER BY BUFFALO BAYOU SHIP-CHANNEL COMPANY OF ITS WORKS AT MORGAN'S POINT, TEXAS, TO THE UNITED STATES.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., September 19, 1889.

SIR: I have the honor to report that in accordance with the instructions contained in your letter of May 14, 1889, I have called upon the Buffalo Bayou Ship-Channel Company to execute its agreement of February 14, 1881, to transfer to the United States its work at Morgan's Point. A copy of the correspondence is inclosed. It will be seen that the company claims compensation for their property. By implication the question is raised also as to what is the meaning of the term "completion," as applied to the ship-channel in Galveston Bay. The work is not capable of permanent completion. The *original excavation* was completed early in July last, but the portion of the channel excavated the year before had shoaled so that there is not now a channel of the required dimensions from Bolivar Channel to Morgan's Cut.

Very respectfully, your obedient servant,

O. H. ERNST,
Colonel, U. S. Army,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER FROM MAJOR ERNST TO MR. CAVE.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 12, 1889.

SIR: I have the honor to inform you that the original excavation of the ship-channel in Galveston Bay from Morgan's Cut to Bolivar Channel is now practically completed, and that I am directed by the Chief of Engineers to call upon your company to execute the agreement made by it February 14, 1881.

The agreement referred to is found printed upon page 1338, Annual Report of the Chief of Engineers for 1881, and reads, after a preamble, as follows: "Upon the completion of the said improvement we will enter into and subscribe any and all such instrument or instruments as may be necessary or required, in order fully to transfer and surrender to the United States the entire said work, together with the charter and rights aforesaid," the work referred to being your work at Morgan's Point.

The instrument which I suppose to be necessary would be a deed to the land through which Morgan's Canal is cut, including a strip, say, 300 feet wide on each side of the water-way, and extending from Galveston Bay to the San Jacinto River. Will you kindly inform me if you are prepared to execute such a deed to the United States?

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

E. W. CAVE, Esq.,
President Buffalo Bayou Ship-Channel Company, Houston, Tex.

LETTER FROM MR. CAVE TO MAJOR ERNST.

OFFICE OF BUFFALO BAYOU SHIP-CHANNEL COMPANY,
Houston, Tex., July 16, 1889.

SIR: Your favor of the 12th instant has been received. I have the honor to state that it will have reply at the earliest day practicable, in view of the time necessary for the consideration of the matters referred to therein.

Very respectfully, your obedient servant,

E. W. CAVE,
President.

Maj. O. H. ERNST,
United States Engineers.

LETTER FROM MAJOR ERNST TO MR. CAVE.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., August 9, 1889.

SIR: I have the honor to request information as to the time about when I may expect to receive a further reply to my letter of the 12th ultimo upon the subject of the transfer to the United States by your company of its work at Morgan's Point.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

E. W. CAVE, Esq.,
President Buffalo Bayou Ship-Channel Company, Houston, Tex.

LETTER FROM MR. CAVE TO MAJOR ERNST.

OFFICE OF BUFFALO BAYOU SHIP-CHANNEL COMPANY,
Houston, Tex., August 13, 1889.

SIR: I have the honor to acknowledge receipt of your favor of the 9th instant. In reply, I beg leave to state that I confidently expect to make the further reply to your letter of the 12th ultimo at an early date, and certainly not later than the 10th of next month, September.

Very respectfully, your obedient servant,

E. W. CAVE,
President.

Maj. O. H. ERNST,
United States Engineers.

LETTER FROM MAJOR ERNST TO MR. CAVE.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., August 15, 1889.

SIR: I have the honor to acknowledge the receipt of your favor of the 13th instant, stating that you expect to make a further reply to my letter of July 12, 1889, at an early date, and certainly not later than the 10th of next month. Will you kindly furnish me the reasons why it is not practicable to make some definite reply to that letter without further delay?

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

E. W. CAVE, Esq.,
President Buffalo Bayou Ship-Channel Company, Houston, Tex.

LETTER FROM MR. CAVE TO MAJOR ERNST.

OFFICE OF BUFFALO BAYOU SHIP-CHANNEL COMPANY,
Houston, Tex., August 17, 1889.

DEAR SIR: I have the honor to acknowledge receipt of your favor of 15th instant. The time occupied is incident to corporate management, in which the executive officers are but the representatives of those whose interests are confided to their supervision, and who are entitled to be considered and afforded time to make known their views. I regret that you did not name a time in which reply must be made, in which case every effort would have been made to make prompt answer. I hope you will not consider there has been any unreasonable delay.

While I hope and expect to make the "further reply" named, at an early day, and not wait until the latest day named, I deem it proper now, in order that there may be no misunderstanding as to the intentions of the company, to say, that I feel fully authorized to state it has been and is at all time prepared to complete the transaction covered by the agreement with the Government of the United States, upon the terms and in the manner provided for, upon such notice as affords reasonable time for corporate action.

Very respectfully, your obedient servant,

E. W. CAVE,
President.

Maj. O. H. ERNST,
United States Engineers.

LETTER FROM MR. CAVE TO MAJOR ERNST.

OFFICE OF BUFFALO BAYOU SHIP-CHANNEL COMPANY,
Houston, Tex., September 10, 1889.

SIR: I have the honor to say, replying to your letter of 12th July, 1889, referred to in my previous letters of July 16 and August 13 and 17, 1889, that, assuming that the Government of the United States has completed a ship-channel for vessels of 12 feet draught from Bolivar Channel to the channel constructed by this company (as to which we shall no doubt have formal assurance in due time), this company is prepared to turn over their work at Morgan's Point and to surrender their charter, granted by the legislature of Texas, and the rights accruing thereunder, to the United States, upon receiving from the United States the stipulated compensation therefor.

Before entering into the details as to the precise manner of making this transfer will you kindly advise me whether the United States is now prepared to pay the agreed compensation for this transfer, or whether further action on the part of Congress is to be awaited in that behalf, and oblige,

Your obedient servant,

E. W. CAVE,
President.

Maj. O. H. ERNST,
United States Engineers.

V 3.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

The Trinity River empties into Galveston Bay through several mouths or passes, near its northeast extremity, about 35 miles from Galveston. The relative importance of the passes appears to have varied considerably. The one generally used by vessels of late years is the Middle Pass. The channel depth in the river immediately above the passes is 16 feet or more. The depth in the Middle Pass is 9 feet or more. Opposite the mouth of each of the passes is a bar, the depth upon the crest of that of the Middle Pass being now 3 feet 2 inches. The trade using the river is carried in sailing vessels which draw from 3 feet to 4 feet 8 inches. To accommodate them there should be a channel 5½ to 6 feet deep.

It is stated upon page 539 of the Annual Report of the Chief of Engineers for 1871 that Pass A, or the Southeast Pass, was excavated by the Government in 1865 to facilitate the supply of fuel to the troops stationed in Galveston. This improvement was subsequently obliterated by natural causes. In 1880 a channel was dredged across the bar at the mouth of Middle Pass, its length being 4,800 feet, its average width 110 feet, and its least depth 5½ feet, the amount of material removed being 47,300 cubic yards. (See Annual Report Chief of Engineers, 1881, p. 1341.) This channel was also obliterated by natural causes. In the winter of 1884 and spring of 1885 a channel was again dredged through the bar at the mouth of Middle Pass to a least depth of 6 feet, its length being 3,750 feet. A wooden revetment was placed upon the west side of the channel for a length of 2,775 feet, and upon the east side for a length of 1,280 feet, of which the object was to prevent the excavated material deposited near by from flowing back into the cut. In my annual report for 1887 I stated that the channel had shoaled in some places; that additional dredging was needed, and that the revetments required repairs and extension. The cost of the necessary work was estimated at $25,000.

An appropriation of $12,500, for continuing the improvement, having been provided in the river and harbor act of August 11, 1888, a survey was undertaken this year in April to ascertain the present condition of

the bar and of the works executed for its improvement during the winter of 1884–'85. It was found that the channel, though not entirely obliterated, had shoaled considerably, and had a least depth at one point of only 3 feet 2 inches. The west revetment is in fair condition for a length of about 1,800 feet from its up-stream end; the remaining 975 feet has been much damaged. The east revetment is in good condition for a length of 300 feet from its down-stream end; of the remainder, only the piles remain. Evidence of the action of the teredo is found at the down-stream end of the west revetment, but for most of the distance the wood appears to have been protected by the presence of fresh water.

The results obtained in 1885 could, perhaps, have been maintained by a small amount of annual dredging, though there are no data for estimating exactly what the amount of it would have been and what it would have cost. The new appropriation might be applied to again dredging out the channel, thus affording temporary relief, and to some repairs of the revetments. But in view of the irregularity with which appropriations are made, it is believed that better results will in the end be obtained by building two parallel jetties, which shall concentrate the flow of the river and keep it at work upon the bar, whether there be funds available for continuing the improvement or not. Necessarily the jetties must be of a cheap form. It has accordingly been decided, with your approval, to build two parallel timber jetties, extending from the mouth of the middle pass across the bar to a depth of 6 feet in Galveston Bay. The west jetty is to follow the line of the present west revetment, and to embody as part of itself so much of that work as is serviceable. The interval between the two jetties is to be 275 feet. The form of construction is a continuous line of sheet-piling, driven 10 feet into the ground, and projecting 4 feet above the water surface, strengthened by a double row of stringers at top and another double row at the water-surface, which are in turn embraced between and bolted to stiff piles in pairs driven to a penetration of 15 feet, the interval between the pairs being 8 feet. The total length of the west jetty is to be 7,750 feet, and of the east jetty 7,600 feet. Low submerged dams or sills are to be placed across the two other principal passes to prevent their enlargement.

The total estimated cost of the two jetties and the two sills, including the removal of so much of the old east revetment as may remain after the completion of the new work, is $55,000. This is an increase of $30,000 above the estimates heretofore submitted, but the latter did not include the cost of maintenance. The present estimate is expected to create a channel 8 feet deep between the jetties, and to maintain it during the life of the timber, or say eight years.

It is proposed to apply the funds now available to the west jetty, beginning at the up-stream end, and working down-stream as far as they will go. Proposals for doing the work by contract have been invited by public advertisement, and are to be opened on the 26th of July.

A special agent was employed throughout the year, whose business it was to make a daily record of all in-coming and out-going trade. The commercial statistics compiled from this record are appended.

The amount estimated for carrying on the improvement during the fiscal year ending June 30, 1891, is $42,500, with which sum it is proposed to complete the west jetty and build the east jetty.

The original estimated cost of the work as here revised is	$89,500.00
The aggregate amount appropriated to July 1, 1889, is	47,000.00
The amount actually expended is	34,535.97

The work is located in the collection district of Galveston. The nearest lighthouse is at Redfish Bar.

The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1889, was $153,040.51.

Money statement.

Amount appropriated by act of August 11, 1888	$12,500.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	35.97
July 1, 1889, balance available	12,464.03
Amount (estimated) required for completion of existing project	42,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	42,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR FISCAL YEAR ENDING JUNE 30, 1889.

[Reported by Special Agent L. G. Chambers, of Wallisville, Tex.]

The trade of Trinity River was carried in 36 vessels, schooners, and sloops, exclusively, plying between Wallisville and Galveston. Their length on deck is from 24 feet to 65 feet; draught when loaded from 2 feet to 4 feet 6 inches, and their tonnage ranging from 3 tons to 32 tons each. They made 1,330 trips during the year, 668 arrivals and 663 departures. The total tonnage of vessels arriving was 8,372 tons, and of vessels departing was 8,365 tons. Freight carried was as follows:

Article.	Quantity.	Approximate value.	Freight charges.
IMPORTS.			
General merchandise.....barrels..	2,498	$13,430.00	$478.30
EXPORTS.			
Alligator hides.....number..	1,450	605.00	30.00
Charcoal.....barrels..	26,101	12,053.70	2,673.90
Cotton.....bales..	207	9,255.00	254.60
Seed-cotton.....tons..	96	5,137.00	247.51
Wood.....cords..	6,014	29,778.00	12,093.00
Piling.....pieces..	806	1,909.00	52.00
Railroad ties.....do....	1,055	527.50	157.25
Eggs.....dozen..	4,133	539.80	116.19
Poultry.....do....	31	124.00	25.00
Fish.....pounds..	24,680	1,229.20	358.45
Moss.....do....	8,800	264.00	60.00
Clam shells.....barrels..	1,350	270.00	135.00
Calves.....head..	98	652.00	70.00
Hogs.....do....	20	100.00	20.00
Sheep.....do....	28	28.00	5.00
Total.....		62,472.20	16,797.90

Total value of trade for the year, approximately, $75,902.20

V 4.

IMPROVEMENT OF BUFFALO BAYOU, TEXAS.

A description of this stream and of the work projected for its improvement was given in my annual report for 1887.

At the date of my last annual report the work was suspended for want of funds. A new appropriation of $25,000 having been made by the river and harbor act of August 11, 1888, a contract was entered into

October 26, 1888, with J. J. Atkinson for continuing the work, and active operations were resumed December 6. Much shoaling had occurred in the portion of the channel dredged out the previous year between White Oak Bayou and a point 2½ miles below, particularly at the "turning point" at the mouth of White Oak Bayou. This ground was again gone over with the dredge. The work of easing Bends 2 and 3, situated about 6 miles below White Oak Bayou, which was left unfinished last year, was continued. That at Bend 2 was completed, and that at Bend 3 made good progress. At Bend 4, situated about one-third of a mile above Bend 3, the bank was cut down by scrapers to near the water-surface with a view to cutting off the point, but no excavation was made under water.

The total amount of material excavated under contract from the bed was 48,104 cubic yards soft material and 1,795 cubic feet sunken logs. The force was engaged also 708 hours removing stumps and wrecks from the bed. The total amount excavated above the water-surface by scrapers and mule teams was 5,516 cubic yards. The contractor had also in the course of his contract removed about 12,000 cubic yards at depths greater than 10 feet, the limit below which he was not entitled to payment. Before this year's work was begun the available depth for the portion of the stream dredged was from 5½ to 7 feet, and the width of the channel for this depth was from 30 to 60 feet. These dimensions were increased to a minimum depth of 9½ feet with a width of from 40 to 80 feet.

Under the terms of the contract it was to have been completed June 30, 1889, but it was not entirely finished at that time, and an extension to July 31 had been applied for. The work remaining to be done with the funds available will be applied to easing Bend 3, which it is expected will be completed.

The work was carried on under the immediate supervision of Mr. R. B. Talfor, assistant engineer, whose report is hereto appended, to which reference should be made for details.

With the amount of the estimate, $50,000, for continuing the work during the fiscal year ending June 30, 1891, it is proposed to again go over the ground heretofore worked over, widening the water-way where the width is less than 100 feet and where the cost of widening is not excessive, and to deepen the channel where it is less than 9 feet at mean low tide by dredging; to ease the sharpness of bends by cutting off the points, by scraping and dredging, and to remove such sunken logs and stumps from the bed and such overhanging trees from the banks as may interfere with navigation, all the work being located between White Oak and Simm's bayous.

As stated in former reports, "it is reasonably certain that the amount estimated for the completion of the present project, which has heretofore accompanied the annual reports upon this work, will not be sufficient for that purpose. To make a new estimate would involve a resurvey, which is expensive. Moreover, it is impossible to make an accurate estimate of what the final cost will be if the work be prosecuted as heretofore, under small and irregular appropriations. As available funds are limited and can not well be spared for a survey, I have thought it proper, with this explanation, to retain the old estimate."

The principal trade of the bayou is carried on by the Houston Direct Navigation Company with tugs and barges. A statement of the freight carried by them during the year is appended. Many small vessels also visit the bayou. To ascertain the extent of this trade a special agent was employed throughout the year, whose business it was to keep a

daily record of all such vessels. The information compiled from this record is also appended.

The original estimated cost of this work was*	$385,299.75
The aggregate amount appropriated to July 1, 1889, is	143,750.00
The amount expended, including outstanding liabilities, is	138,393.82

The work is located in the collection district of Galveston. The nearest lighthouses are those in Galveston Bay. The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1889, was $153,040.51.

Money statement.

July 1, 1888, amount available		$1,087.80
Amount appropriated by act of August 11, 1888		25,000.00
		26,087.80
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$18,191.52	
July 1, 1889, outstanding liabilities	2,540.10	
July 1, 1889, amount covered by existing contracts	4,233.44	
		24,965.06
July 1, 1889, balance available		1,122.74
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		50,000.00

Abstract of proposals for improving Buffalo Bayou, Texas, received in response to advertisement dated September 10, 1888, and opened October 10, 1888, at Galveston, Tex., by Maj. O. H. Ernst, Corps of Engineers.

No.	Name and address of bidder.	Character of work.	Price.	Amount.
1	John J. Atkinson, Houston, Tex.	Dredging material under water, 75,000 cubic yards, per yard.	$0.28	$34,192.50
		Dredging and scraping material above water, 12,500 cubic yards, per yard.	.24	
		Removing sunken logs, 3,000 cubic feet, per cubic foot.	.06	
		Removing overhanging trees, 250 cubic feet, per cubic foot.	.05	
		Removing stumps as may be necessary, per cent. above actual cost.	.10	

Only one bid received. Acceptance recommended.

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

HOUSTON, TEX., *June* 30, 1889.

SIR: I have the honor to make the following report relating to the improvement of Buffalo Bayou, Texas, for the current fiscal year ending June 30, 1889.

The work of improvement consisted in, 1st, deepening the channel where it was less than 9 feet depth at mean low tide to 10 feet, and making the greatest bottom width of that depth where it would not interfere with the stability of the banks; 2d, cutting off bends by scraper and dredging; 3d, removing stumps, logs, and such overhanging trees that might interfere with navigation.

On October 26, 1888, a contract was entered into with Capt. J. J. Atkinson for the removal of certain materials estimated approximately as follows: 75,000 cubic yards of earth under water, at 28 cents per cubic yard; earth-work above water, 12,500

* Subject to revision.

cubic yards, at 24 cents per cubic yard; sunken logs, 3,000 cubic feet, at 6 cents per cubic foot; overhanging trees, 250 cubic feet more or less, at 5 cents per cubic foot, and the removal of stumps at 10 per cent. above cost.

On December 6, 1888, active operations began at Bend No. 2, which had previously been cut down by mule teams and scrapers, when one Osgood dredge and derrick were put to work at the lower end of the bend, with the derrick on the bank. This work was completed February 12, 1889, but owing to the high water of December, 1888, and January, 1889, it was found that a considerable shoaling had taken place over the point dredged; this area was redredged, and the work completed by February 25, 1889. This plant was then moved up to the "turning point," at Houston, the junction of the White Oak and Buffalo bayous, where a shoaling from 2½ to 4 feet had taken place during the high water of December and January which seriously interfered with the turning of the barges and schooners engaged in the bayou trade. On March 28 an extra dredge and derrick was put on the work, and after the completion of the dredging at the "turning point" both plants were moved down-stream and removed a number of shoal places, also taking out such logs and stumps that interfered with navigation, besides taking out the hulls of two steam-boats that were wrecked in 1839 or 1840. The location of all the work done is shown on the reduced chart (scale $\frac{1}{10000}$) acompanying.*

At the present writing the bayou has a navigable depth of 9½ feet with a bottom width averaging from 40 to 80 feet. This depth, especially at the "turning point" at Houston, is not to be relied on, owing to the broken condition of the banks on the White Oak Bayou, which are denuded during heavy rains and freshets, the material of which is carried down and deposited at the junction of the two bayous. This silting up at the "turning point" might be controlled to a great extent by a systematic planting of Bermuda grass over the banks of the upper bayous. In connection with the above, I would respectfully call your attention to the constant filling taking place below the natural and artificial drains that empty into the bayou. This filling might be controlled to a certain extent if bulkheads were built at their mouths to such heights as would check the rapid flow of the drainage water and cause a precipitation of a greater portion of the sediment carried in suspension in the "catch basin" formed by the bulkheads.

The contractor finding that he could not complete his contract within the time specified (June 30, 1889), applied for an extension of thirty days, which will enable him to complete the work under the present appropriation.

The two dredges and derricks are now at work at Bend No. 3, and will probably finish by the 15th proximo.

Amount of work done from December, 1888, to July 1, 1889, viz.:

Material under water dredged	cubic yards..	48,104
Material above water dredged	do....	282
Scraper work at bends Nos. 3 and 4	do....	5,616
Logs removed	cubic feet..	1,795
Stumps removed	hours..	505
Removing two wrecks	do....	203
Removing overhanging trees	cubic feet..	1,509

Very respectfully, your obedient servant,

R. B. TALFOR,
U. S. Assistant Engineer.

To Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS DURING THE FISCAL YEAR ENDING JUNE 30, 1889.

[Reported by Special Agent L. F. Allien, of Houston, Tex.]

The principal trade of Buffalo Bayou was carried on by the Houston Direct Navigation Company, a separate statement of which is given below. In addition there was considerable traffic maintained by small vessels as follows, viz: It was carried in thirty-eight sloops and schooners ranging in length from 28 to 80 feet, draught when loaded 3 to 6 feet, with tonnage of from 3 to 45 tons each; one tow-boat, the *Justine*, 50 feet long, 4 feet draught, and tonnage of 9 tons; and two barges, each 50 feet long, 4 feet draught, and tonnage of 25 tons. They made 735 trips during the year, 371 ar-

* Chart not forwarded.

rivals and 363 departures. The total tonnage of vessels arriving at Houston was 2,959 tons, and of vessels departing was 2,919 tons. The freight carried was as follows:

Article.	Quantity.	Approximate value.	Freight charges.
IMPORTS.			
Lumber ..... M feet..	199	$5,490.00	$1,116.00
Wood ..... cords..	430	1,300.00	410.00
Water-melons ..... number..	42,050	4,000.00	2,000.00
Fish ..... bunches..	150	37.50	32.50
Oysters ..... barrels..	2,317	3,460.50	3,071.01
Gravel, sand, and shells ..... do....	630	127.75	40.00
General merchandise	.....	19,074.05	2,420.43
Total	.....	33,479.80	9,089.94
EXPORTS.			
General merchandise	(not stated.)	8,563.50	2,079.78

STATEMENT OF THE COMMERCE OF BUFFALO BAYOU, TEXAS, CARRIED BY THE HOUSTON DIRECT NAVIGATION COMPANY, DURING THE FISCAL YEAR ENDING JUNE 30, 1889.

[As reported by L. Megget, esq., secretary of the company.]

The freight was carried in barges, 122 feet to 173 feet long, 5 feet draught, tonnage 115 to 254 tons each. These were towed by tugs, 54 to 94 feet long, 4 feet 6 inches to 7 feet draught, tonnage 14 to 105 tons each. The amount and value of freight and freight charges were as follows:

Article.	Quantity, pounds.	Approximate value.	Freight charges.
Cotton	82,453,800	$7,420,842.00	$70,319.91
Cotton-seed, cake, and meal	25,255,920	25,255.90	12,672.26
Coal	6,912,590	17,281.50	3,086.43
Oils	452,100	8,842.00	455.19
Railroad iron	2,240,000	67,200.00	750.00
Paving stone	50,000	725.00	25.00
Shingles	240,000	1,920.00	87.37
General merchandise	225,800	33,870.00	273.64
Total	117,820,210	7,575,336.40	87,625.50

Total value of trade for the year, approximately:

Carried by the Houston Direct Navigation Company	$7,575,336.40
Carried by other parties	42,043.30
Total	7,617,379.70

V 5.

IMPROVEMENT OF MOUTH OF BRAZOS RIVER, TEXAS.

The river and harbor act of August 11, 1888, having omitted this work from the list of those for which appropriations were made, it was inferred that Congress had abandoned the work, and I was authorized by your letter of May 7, 1889, to drop it from the list of those under my charge. Nothing was done during the year. The record is closed with this report.

Money statement.

July 1, 1888, amount available	$16,651.57
July 1, 1889, amount available	16,651.57

V 6.

IMPROVEMENT OF PASS CAVALLO, INLET TO MATAGORDA BAY, TEXAS

The river and harbor act of August 11, 1888, having omitted t work from the list of those for which appropriations were made, it w inferred that Congress had abandoned the work, and I was authoriz by your letter of May 7, 1889, to drop it from the list of those und my charge. Nothing was done during the year. The record is clos with this report.

Money statement.

July 1, 1888, amount available	$35,449.
July 1, 1889, amount available	35,449.

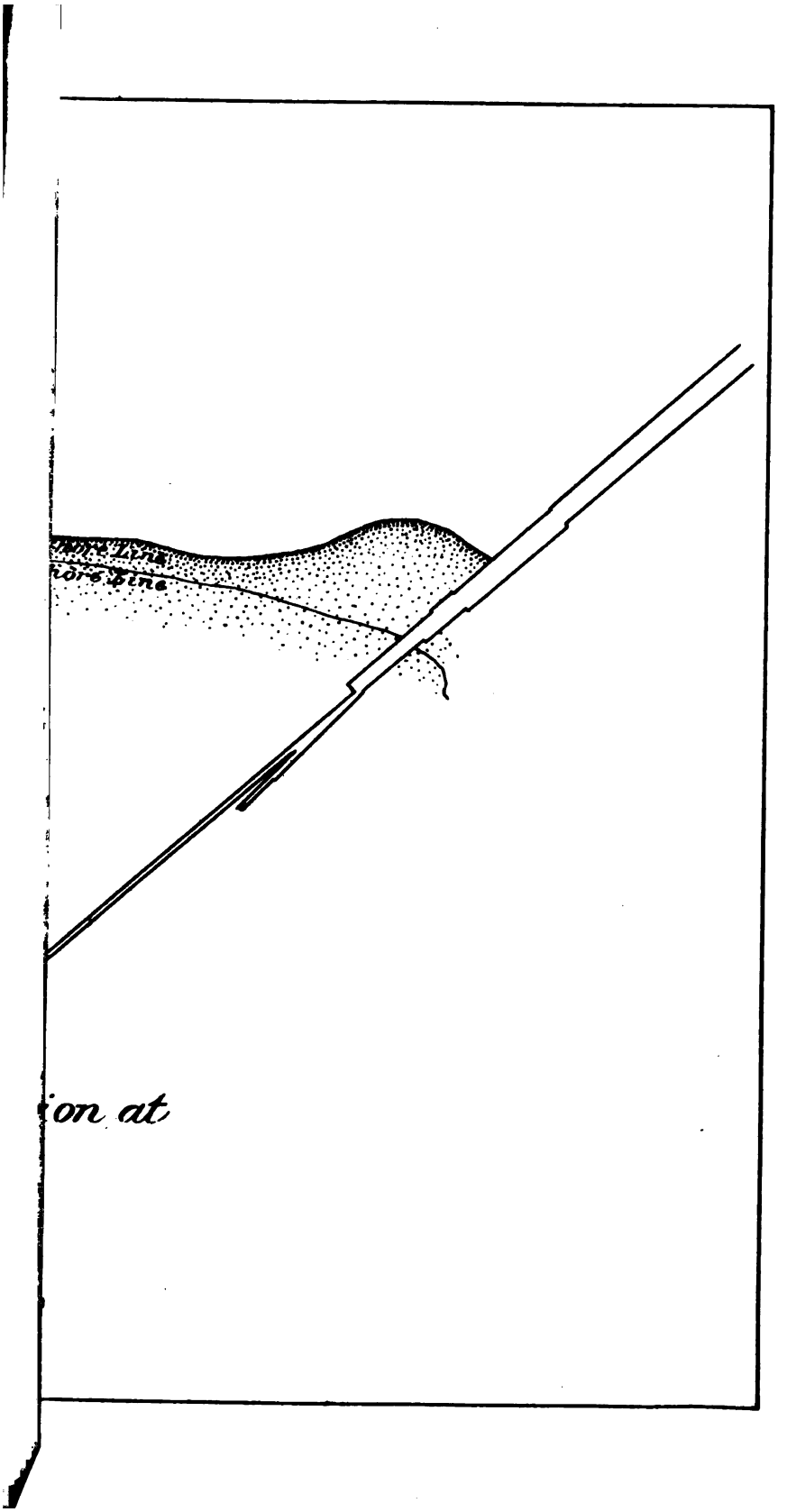
V 7.

IMPROVEMENT OF ARANSAS PASS AND BAY UP TO ROCKPORT AN CORPUS CHRISTI, TEXAS.

A description of this locality, and of the works undertaken for i improvement, was given in my last annual report. At the date of th report active operations in the field were suspended for want of fund As soon as practicable after the passage of the act of August 11, 188 which contained an appropriation of $100,000 for this improvement, new contract was advertised and let for continuing the revetment the head of Mustang Island. The revetment, consisting of a layer riprap about 18 inches thick, extending from the bottom of the chann to high-water mark, had been placed last year for a total length of 1,8 feet, of which 1,280 feet was finished and 615 feet carried up from t bottom of the channel only to low-water mark. The work this ye consisted of completing this unfinished portion and extending the reve ment seaward a distance of 830 feet. Operations were resumed in Jan ary, under contract with Charles Clark & Co., of Galveston, and we suspended in May, the revetment having been completed as far as no appears to be necessary (see sketch). The area of the slope covered b the new work is 30,948 square yards. The total length of the reve ment is 2,725 feet. It has thus far proved thoroughly efficient. Th work was under the local supervision of Mr. Gerald Bagnall, assista engineer, whose report is hereto appended, giving further details.

What would be the effect of holding the southerly shore of Arans Pass by an efficient revetment and leaving the northerly shore free advance, except for the action of the tides, has been a question abo which some engineers have had doubts. Upon the completion of t work in May several cross-sections of the gorge were carefully measur and a comparison was made with the survey of 1887. It was found th the northerly shore-line had advanced about 280 feet, diminishing b that amount the surface width of the gorge, but it had been accompanie by a deepening which left the area of cross-section about the same. may be found desirable hereafter, in view of these changes, to diminis the interval between the proposed jetties.

The revetment having been completed the work was suspended, lea ing an unexpended balance of funds of something over $40,000. Th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sum is not sufficient to justify beginning the construction of a jetty. In their report of July 19, 1887, the Board of Engineers gave it as their opinion that the sum of $500,000 should be available before jetty work should be begun. I beg leave to join in that opinion. The sum estimated for continuing the work during the year ending June 30, 1891, is $500,000, with which, together with the unexpended balance, it is proposed to begin the work of building up the shore end of the old south jetty and extending it seaward upon the lines indicated in my annual report of 1887.

A special agent was employed during the year at Corpus Christi and another at Rockport, who kept a daily record of all incoming and outgoing trade. The commercial statistics of Aransas Pass compiled from these records, and also the statement of the collector of the port at Corpus Christi, are hereto appended.

The original estimated cost of this work as revised in 1887 is	$2,052,543.72
The aggregate amount appropriated to July 1, 1889, is	581,250.00
The amount expended, including outstanding liabilities, is	536,930.41

In addition to this (contributed in 1883 by citizens of Rockport and Corpus Christi) there was expended the sum of $9,938.93.

The work is located in the collection district of Corpus Christi, Tex. The nearest light-house is upon Harbor Island, just inside the entrance. The amount of revenue collected at the port of Corpus Christi during the fiscal year ending June 30, 1889, was $72.30.

Money statement.

July 1, 1888, amount available		$2,182.20
Amount appropriated by act of August 11, 1888		100,000.00
		102,182.20
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$57,231.11	
July 1, 1889, outstanding liabilities	631.50	
		57,862.61
July 1, 1889, balance available		44,319.59
Amount (estimated) required for completion of existing project		1,471,293.72
Amount that can be profitably expended in fiscal year ending June 30, 1891		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for protecting the shore of Aransas Pass, Texas, from erosion, received in response to advertisement dated September 10, 1888, and opened October 10, 1888, at Galveston, Tex., by Maj. O. H. Ernst, Corps of Engineers.

[18,000 cubic yards riprap.]

No.	Name and address of bidder.	Per cubic yard.	Amount.
1	Charles Clarke & Co., Galveston, Tex	$2.99	$53,820
2	A. M. Shannon & Co., Galveston, Tex	3.10	55,800

No. 1 lowest. Acceptance recommended.

REPORT OF MR. GERALD BAGNALL, ASSISTANT ENGINEER.

GALVESTON, TEX., *June* 15, 1889.

SIR: I have the honor to make the following report of operations for the "improvement of Aransas Pass and Bay up to Rockport and Corpus Christi, Tex.," which have been carried on during the fiscal year ending June 30, 1889.

The work projected and carried out was the completion to high-water mark of that part of the protection of Mustang Island which was begun in 1887 and suspended in 1888 on account of want of funds, and the extension of the protection 830 feet farther towards the Gulf.

The same methods were used as last year, the bank being covered with a layer of riprap 18 feet thick from near the bottom of the channel to high-water mark, except for about 200 feet at the Gulf end, where it was commenced in 24 feet of water.

The accompanying sketches* show: The progress of the work (Plate I); comparative cross-sections of revetment (Plate II); comparative cross-sections of the gorge, 1887 and 1889 (Plate III); profile of St. Joseph's Island (Plate IV).

In accordance with your instructions dated January 3, 1889, I proceeded to Aransas Pass on January 8 and made preparations for commencing work. An examination of the revetment placed last year was made and it was found to be in good condition, no apparent settlement having taken place.

The shore of Mustang Island was found to have built up considerably except opposite groin No. 5. A large quantity of sand had accumulated behind the artificial shore-line between spurs Nos. 1 and 2, and as this continues to increase it can be but a comparatively short time before the basin which was created there by the construction of the artificial shore-line must be filled up to the level of the adjacent shore. No perceptible change, however, was found to have taken place immediately behind that part of the artificial shore-line west of spur No. 1, but there has been some accretion to the shore of Turtle Cove in that vicinity.

The shore of St. Joseph's Island was found to have advanced about 280 feet at the point since 1887, while the cross-section area of the gorge has remained practically the same.

Year.	No. of cross-section.	Surface width.	Area.	Location on line.
		Feet.	*Square feet.*	
1887	1	1,785	19,246	A B.
1887	2	1,765	17,416	C D.
1887	3	1,900	18,000	E F.
1889	1	1,304	18,624	A B.
1889	2	1,492	17,791	C D.
1889	3	1,754	18,208	E F.

The first load of stone was delivered at the works on January 16 and the last on May 23. During that period much delay was occasioned by the heavy rainfall, which caused a succession of washouts on the railroad over which the stone had to be carried, so that the contractors, Messrs. Charles Clarke & Co., were obliged to ask for an extension of time of forty-five days from March 31, and again for a second extension to June 15, both of which were granted.

The contractors had a well-equipped plant on the ground consisting of one towboat, three barges, and one schooner, and were able to deliver and place the stone as fast as they received it, notwithstanding the long tow from Corpus Christi. They were allowed the use of the large Government building, provided they agreed to make such repairs as were required of them, which terms they accepted.

The method of placing the stone was as follows: Beginning at the foot of the slope the protection was placed in convenient sections in towards the shore. About half the load having been placed in this manner, the barge would be floated into shoal water and beginning at the shore end the balance of the load placed working out. The width of the sections was equal to the length of the load on the barge.

The means adopted to secure an equal distribution of the stone was by the use of ranges in conjunction with sextant angles. The ends of the load being kept on the line of the ranges, the barge was moved 5 feet at a time by means of sextant angles, and an amount of stone sufficient to cover that width thrown off at each move. By using the angle contained between the line of the ranges and some distant station on the transit line, only one angle was necessary for each location, and this being large, great accuracy could be obtained in determining the distance to move the barge.

An examination of the work was made by a submarine diver, commencing April 7 and ending May 24, 1889. During this period he examined the revetment between stations 17 and 26 of the transit line. He reported the ground well covered, and

* Plates 2, 3, and 4 not forwarded.

brought up a number of samples of the stone placed this year and last. An examination of these showed that in two months rock will become completely covered with barnacles, and that in twelve months they may become covered with oysters. A small 20 feet by 50 feet barge was used for diving operations.

A tide-house was erected near the west end of the artificial shore-line and an automatic tide-gauge placed in it.

At the end of the season a considerable deposit of sand had accumulated on the revetment while the interstices throughout were filled. During the progress of the work it was found that as the stone was placed an accretion would almost immediately take place to the east and northeast of it, causing much irregularity in the slope.

Some beach grass planted on the flat which extends across the head of Mustang Island promises to be a success; it was transplanted from other points on the island, and is not only in a healthy condition but is spreading rapidly and has already commenced to accumulate sand. Only a small proportion of these plants died, but as the season was unusually propitious on account of the heavy rainfall it would be premature to draw conclusions as to the probability of making it a success under ordinary conditions.

The personnel of Government employés remained substantially the same as last year.

A transit line was established on St. Joseph's Island, beginning at the point and extending up to near Aransas Wharf. A line of levels run over this showed the minimum elevation above the plane of M. L. T. to be 2.8 feet.

The following is a summary of the material placed:

SUMMARY.

Riprap expended	cubic yards..	15,988.87
Riprap remaining on hand	do....	148.32
Superficial feet of slope covered		278,531.
Length of spur (No. 3)	feet..	205.
Cubic yards in revetment proper		*15,685.05
Cubic yards in spur No. 3		103.82

There was delivered, besides, 437.63 cubic yards of stone, which was rejected on account of its inferior quality.

Very respectfully, your obedient servant,

GERALD BAGNALL,
U. S. Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

[Reported by Special Agent Thomas Allen, of Corpus Christi, Tex., and Special Agent John McBride, of Rockport, Tex.]

CORPUS CHRISTI, TEXAS.

The trade of Corpus Christi was carried by twenty-seven schooners having a length on deck from 51 to 99 feet, draught when loaded of from 4 feet 6 inches to 7 feet, and a tonnage of from 18 to 81 tons. They made 237 trips during the year, 119 arrivals, and 118 departures. The total tonnage of vessels arriving was 4,718 tons, and of vessels departing, 4,681 tons. The freight was principally lumber from Lake Charles, and bones, cotton, hides, and wool to Galveston, as follows:

Articles.	Quantity.	Approximate value.	Freight charges.
IMPORTS.			
Coal ..... tons..	558	$4,044.23	$1,423.00
Lumber ..... M feet..	4,274	66,525.96	23,506.49
Shingles ..... M...	1,180	4,300.00	632.00
Total	.....	74,870.19	25,566.49
EXPORTS.			
Bones ..... tons..	48	384.00	101.00
Cotton ..... bales..	243	1,062.00	78.50
Hides ..... tons..	130	21,441.98	260.92
Wool ..... do ..	66	18,451.03	131.37
Stone ..... do ..	490	1,470.00	737.00
Total	.....	42,809.01	1,308.79

Total value of trade for the year, approximately, $117,679.20.

*This includes about 200 yards expended in increasing height of shore end.

ROCKPORT, TEXAS.

The trade of Rockport was carried by the steamer *Morgan City*, 219 feet long, 8 feet 3 inches draught, having a tonnage of 537 tons. She arrived and departed four times during the months of July and August, 1888, but made no other trips during the remainder of the fiscal year. Seven schooners, having a length on deck of from 60 to 68 feet, draught when loaded of from 4 feet 6 inches to 6 feet, and a tonnage of from 18 to 55 tons, visited the port between July and November, 1888, but only three vessels arrived and departed during the last seven months of the fiscal year. The freight was as follows:

IMPORTS.

Articles.	Quantity.	Approximate value.	Freight charges.
General merchandise ..... barrels..	1,000	$5,553.00	$792.51
Lumber ..... M. feet..	471	4,586.70	2,374.20
Shingles ..... M...	650	1,624.50	362.50
Total	.....	11,764.20	3,529.21

No exports.
Total value of trade for the year, approximately, $11,764.20.

LETTER FROM CHARLES F. BAILEY, ESQ., COLLECTOR OF THE PORT.

CUSTOM-HOUSE, CORPUS CHRISTI, TEX.,
Collector's Office, July 15, 1889.

SIR: Referring to your letter of the 1st instant, I have the honor to state, 1st, $72.30 was the amount of revenue collected at Corpus Christi and Rockport during the fiscal year ending June 30, 1889; 2d, there were no entrances or clearances of vessels required by law to report; 3d, $23,561.76 was the amount of revenue collected in the district of Corpus Christi during the said fiscal year.

Very respectfully,

CHARLES F. BAILEY,
Collector.

O. H. ERNST,
Major of Engineers.

V 8.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

The river and harbor act of August 11, 1888, contained an appropriation of $25,000 for continuing the improvement during the fiscal year ending June 30, 1889. In my annual report of 1887, upon which this appropriation presumably was based, I stated that a survey of the locality was in progress; that no careful estimate of funds could be prepared in advance of its completion; that it was certain that the estimates contained in the previous annual report by my predecessor were not excessive, and that in order that the work might not be left unprovided for I renewed the estimate of the previous year for its continuation during the present fiscal year. That estimate was $200,000. I had not at that time given the work the careful study which it required, the data for which had not been obtained, but the regular period for sending in the estimates having arrived, the action just mentioned was taken as the best that could be done under the circumstances.

The survey was soon afterwards completed and showed among other things that the works heretofore constructed, which were begun in the spring of 1882, and last suspended in the autumn of 1884, had practically disappeared. If the improvement were resumed it must begin afresh at the beginning. A new method of construction must be employed, and the estimate of cost largely increased. The funds then available, appropriated by the act of August 5, 1886, were not sufficient

to justify beginning the work, and it was not begun. The balance of those funds remaining unexpended August 1, 1888, was $33,904.77, which, added to the appropriation of August 11, 1888, made a total amount available for work this year of $58,904.77. The amount required to construct the works was estimated at not less than $1,130,000. That is, only about 5 per cent. of the total cost was then available. There was no way known to me in which the sum of $59,000 could be expended upon the work without wasting a large part of it. If it were applied to the actual partial construction of a jetty it might be wholly lost. If it were applied to the purchase of material to be stored at some point beyond the reach of the sea, there would be the expense of rehandling the material which would be a great waste. It was accordingly decided to hold the funds in reserve until further instructions from Congress could be received, given in the light of my special report of September 29, 1887, and the report of the Board of Engineers for fortifications and river and harbor improvements, dated November 11, 1887, both of which are to be found with my last annual report. The record of commercial statistics, however, being inexpensive, and being of interest and value whether the works were to be executed or not, was continued. A statement of the trade of the port compiled from this record is hereto appended.

Upon the subject of the estimate of funds required for the future prosecution of the work, I beg leave to repeat my remarks of last year:

Experience here, as well as elsewhere upon the Texas coast, has shown that it is useless to begin the struggle with contending forces involved in building a pier out into the Gulf of Mexico with inadequate means. It may even happen, as it has at Pass Cavallo, that after several years not only no progress will have been made, but the site of the work will have been so injured that it will be cheaper to abandon it and choose another one.

The estimate submitted for carrying on the work during the fiscal year ending June 30, 1891, is $600,000, with which it is proposed to begin the construction of the south jetty. It is based upon the engineering necessities of the case, and not upon the present or prospective importance of the port. It is submitted as a compliance with law, and not as an averment that the interests to be benefitted by it will justify the expenditure. To begin the work with less than this will subject the United States to losses, the amount of which will increase with the degree of departure from the adequate sum mentioned, until a point will be reached where the entire sum will prove a total loss.

If this or some other similar sum can not now be allotted to this locality, I venture to suggest that the improvement be deferred until the funds which can be devoted to it are sufficient to offer a reasonable hope of its being prosecuted with success.

Original estimated cost of the work as revised in 1888	$1,318,590.23
Aggregate amount appropriated to July 1, 1889	247,500.00
Amount expended, including outstanding liabilities	188,650.23

In addition there was appropriated in 1878 $6,000, which was applied to removing a wreck.

The work is located in the collection district of Brownsville. The nearest light-house is the Brazos Santiago light-house on Padre Island. The amount of revenue collected at the port of Brownsville during the fiscal year ending June 30, 1889, was $20,339.86.

Money statement.

July 1, 1888, amount available		$33,909.77
Amount appropriated by act of August 11, 1888		25,000.00
		58,909.77
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$55.00	
July 1, 1889, outstanding liabilities	5.00	
		60.00
July 1, 1889, balance available		58,849.77

Amount (estimated) required for completion of existing project.....$1,071,090.23
Amount that can be profitably expended in fiscal year ending June 30, 1891..... 600,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

[Reported by Special Agent E. J. Kenedy, of Isabel, Tex.]

The trade of Brazos Santiago was carried in two steamers, the *Aransas*, 241 feet long, 10 feet draught, having a tonnage of 678.73 tons, and the *Morgan City*, 219 feet long, 10 feet draught, having a tonnage, 537 tons. Also 12 schooners, 38 to 76 feet long, 2 feet to 5 feet 9 inches draught, having a tonnage ranging from 12 to 69 tons. These vessels ply between Brazos Santiago and Morgan City, Lake Charles and Galveston, and made 158 trips during the year, 80 arrivals and 78 departures, those arriving having a total tonnage of 23,168 tons and those departing having a total tonnage of 23,151 tons.

Besides these, one bark, the *Le Coq*, 180 feet long, 10 feet draught, and tonnage of 180 tons, made one trip from Bordeaux, France, bringing a cargo of oranges, wines, and liquors, and departed for Tuxpan, Mexico, with ballast.

The freight carried was as follows:

Articles.	Quantity	Approximate value.	Freight charges.
IMPORTS.			
General merchandise ..... tons..	10,000	$585,186.00	$51,623.05
Lumber ..... M feet..	1,769	38,911.40	12,244.80
Shingles ..... M..	920	3,477.00	921.00
Oranges ..... number..	17,000	365.00	100.00
Wines and liquors ..... tons..	84	11,500.00	500.00
Total	.....	639,421.40	65,388.85
EXPORTS.			
Bones ..... tons..	673	8,349.00	1,404.77
Corn ..... bushels..	3,456	1,355.40	436.10
Hides, skins, and wool ..... tons..	3,080	163,700.00	10,427.06
Hay ..... do ..	29	340.00	170.00
Seed cotton ..... do ..	130	7,150 00	314.00
Total	.....	180,894.40	12,751.93

Total value of trade for the year, approximately, $820,315.80.

LETTER FROM D. M. BROWN, ESQ., SPECIAL DEPUTY COLLECTOR OF THE PORT OF BROWNSVILLE, TEXAS.

CUSTOM-HOUSE, BROWNSVILLE, TEX.,
Collector's Office, July 19, 1889.

SIR: In answer to your communication under date of July 1, 1889, would beg to state, as follows:

The revenue collected in this district, for the fiscal year ending June 30, 1889, amounts to $50,811.07.

The number, tonnage, and character of the vessels which entered and cleared in this district during the same period are the following: American vessels entered: 5 steam, tonnage 495 tons; 1 sail, tonnage 69 tons; American vessels cleared: 5 steam, tonnage 495 tons. Foreign vessels entered: Steam 1, sail 1, tonnage 281 tons; foreign vessels cleared: Steam 1, sail 1, tonnage 281 tons.

Respectfully,

D. M. BROWN,
Special Deputy Collector.

O. H. ERNST,
Major of Engineers.

TELEGRAM FROM J. J. COCKE, ESQ., COLLECTOR OF THE PORT.

BROWNSVILLE, TEX., *July* 25, 1889.

Amount collected at the port of Brownsville for fiscal year ending June 30 was $20,338.86.

J. J. COCKE,
Collector.

O. H. ERNST,
U. S. Engineer.

V 9.

PRELIMINARY EXAMINATION OF THE RIO GRANDE RIVER FROM EMBUDO, NEW MEXICO, TO EL PASO, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., January 19, 1889.

SIR: I have the honor to report that under the instructions contained in your circular letter of August 28, 1888, a preliminary examination has been made of the Rio Grande River from Embudo to El Paso, Texas. It was made by my assistant, Mr. Gerald Bagnall, aided by Mr. W. E. Angier, assistant engineer. Mr. Bagnall's report, illustrated with sketches of typical portions of the river, is herewith transmitted.

The total distance by river from Embudo to El Paso is about 517 miles, the stream flowing alternately through valleys and cañons. There is considerable variation in the character of the stream, which is described in detail in Mr. Bagnall's report. A general summary is here given. Of the total distance, 34 miles is through cañon, 89 miles through open cañon widening at intervals into small valleys, and 394 miles through open valleys. Through the cañons the course of the stream is very tortuous, the banks are stable and the current is swift, becoming at high water torrential. Through the valleys above San Félipe, which is about 83 miles below Embudo, the banks are rocky and stable. Through the valleys below San Félipe the banks are unstable, being composed of a light sandy soil, and here the river is constantly changing its course.

The distance between banks varies from 40 to 800 feet.

The channel depth at low water varies from 1 to 7 feet, except over rapids, where it is from 6 to 12 inches.

The range between low and high water varies from about 3 feet in some parts to about 8 or 10 feet in others.

The height of the banks in the valleys is generally from about 2 to about 6 feet.

The slope of the stream varies from about 4 feet to the mile in the valleys, to about 52 feet to the mile in White Rock Cañon.

The low-water discharge at Embudo is about 480 cubic feet per second. At El Paso, at the lowest stage, the water ceases to flow, and except in detached pools the bed becomes entirely dry. The diminution in the low water volume in the lower portion of the stream is probably due to evaporation and to the abstraction of portions of it for irrigation purposes.

The obstructions to navigation consist of rapids, shoals, sharp bends, bowlders, and bridges. In the first 83 miles below Embudo rocky rapids occur at intervals of about 800 feet, being still more frequent in the portion which flows through White Rock Cañon. Lower down, shoals, though less frequent, are of constant recurrence. Over one hun-

dred and eighty-five sharp bends are enumerated. There are ten bridges, besides the two at El Paso, several of them being pile-bridges. One stone dam crosses the river. There are also a few snags.

The stream is not now navigable, and it can not be made so by an open channel improvement. An accurate survey and hydrometric observations would be necessary to determine positively whether an improvement by locks and dams could be made or not, but the heavy fall of the river, the lowness of its banks, and the small discharge do not encourage the belief that such improvement would be financially, even if physically, practicable. Certainly there is no public interest which would justify the expenditure of the many millions of dollars which such an improvement would involve. The irrigation of the valley is a matter in which the inhabitants are now deeply interested, while the possible navigation of the river receives little or no attention from them. Any scheme which would militate against the withdrawal of water for irrigation purposes would not be received with favor. They are provided with good railway facilities. In my judgment, the stream is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF ASSISTANT ENGINEER GERALD BAGNALL.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., January 3, 1889.

SIR: I have the honor to make the following report of the examination of the Rio Grande River from Embudo, New Mexico, to El Paso, Texas, made in accordance with instructions received in your letter of October 12, 1888.

I left Galveston October 19, accompanied by Mr. W. E. Angier, assistant engineer, and one oarsman, and arrived at Santa Fé, N. Mex., October 23.

Having purchased eleven burros, with the necessary camp and mess outfit, hired two ponies, and engaged the services of a guide, a cook, and two packers, we started from Santa Fé for Embudo by road October 26, taking with us a portable canvas boat, and arrived there the night of October 29.

On the following day I commenced the examination of the river, which occupied till the 14th of December, when we arrived at El Paso. Here I sold the outfit at public auction, paid off the men engaged at Santa Fé, and returned to Galveston, arriving there on December 18.

The total time occupied by this reconnaissance was two months, of which we were engaged forty-five days in making the examination from Embudo to El Paso. Of these forty-five days, deducting Sundays and stormy weather, thirty-four were working days.

The total estimated length of river examined was 517 miles, making an average of 15 miles for each working day. The actual length of river examined daily varied from 7 to 30 miles, according to the condition of the roads and the depth of water in the river.

Up to November 28, when the river rose about half a foot, traveling by boat was very difficult on account of the constant dividing and consequent shoaling of the channel. With the exception of one day above White Rock Cañon we used the boat over the entire route and found it invaluable.

A compass line was run, distances estimated, and the river sketched as we advanced.

The Rio Grande from Embudo to El Paso flows alternately through cañons and valleys. The estimated length of the low-water channel is about 517 miles; of this 34 miles is through cañon, 89 miles through open cañon, widening at intervals into small valleys, and 394 miles through open valleys.

Through the cañons the course of the river is tortuous and has many sharp bends. The banks are stable and the current swift.

Through the valleys above San Felipe the course of the river is tortuous, the banks stable to height of from 2 feet to 4 feet above the lowest stage, and the width of the channel in ordinary high stages permanent.

In the valleys below San Felipe the river flows through a channel of the most unstable character, the banks and the bed being composed of a light sandy soil, the latter in many places of a quicksand character. The river is therefore constantly changing its channel and in high stages frequently scours out a new one at a considerable distance from the old.

A noted instance of this is to be seen at Mesilla. The river formerly ran east of that town, it now flows 2 miles to the west. This change was caused by an irrigating ditch, which during a very high stage of the river scoured out to such an extent that it carried the entire stream from its old channel.

To aid in my description I shall take the river by divisions, accompanying each by one or two sketches of portions of that division showing its physical characteristics.

The plates inclosed are as follows:

Plate No. 1, sketch of the Rio Grande from Embudo to El Paso, showing the location of the divisions.
Plate No. 2, sketch of division No. 1.
Plate No. 3, sketch of part of division of No. 2.
Plate No. 4, sketch of part of division No. 3.
Plates Nos. 5 and 6, sketches of parts of division No. 4.
Plate No. 7, sketch of part of division No. 5.
Plate No. 8, sketch of part of division No. 6.
Plate No. 9, sketch of part of division No. 7.
Plates Nos. 10 and 11, sketches of parts of division No. 8
Plate No. 12, sketch of part of division No. 9.
Plate No. 13, sketches of parts of division No. 10.
Plate No. 14, sketch of part of division No. 11.
Plate No. 15, sketch of part of division No. 12.

DIVISION NO. 1 (1ST TO 4TH MILE), PLATE NO. 2.

Embudo, situated in Black Rock Cañon, consists of a depot, a store, and one residence.

The Rio Grande comes down to this point a stream of clear water and flows through Black Rock Cañon for a distance of 4 miles, with a fall of about 14 feet in the mile. It has a width at its lowest stage of from 50 feet to 100 feet, and a depth of from 2 feet to 7 feet.

The range between low and ordinary high stage is about 8 feet. The sides of the cañon have a slope of from 20 degrees to 30 degrees with the horizontal, and are composed of volcanic rock imbedded in clay.

This cañon is 800 feet deep. Above on both sides are mesas covered with grass and a few pine trees.

One arroya comes in from the east.

Velocity measurements taken immediately above Embudo at the lowest stage showed a discharge of 28,700 cubic feet per minute. There are rapids about every 800 feet.

The river is obstructed by a large number of bowlders and several sharp bends. There is a wagon-road on the east, and the Denver and Rio Grande Railroad on the west side.

Rock suitable for works of improvement is abundant. The nearest heavy timber is 18 miles distant.

DIVISION NO. 2 (4TH TO 35TH MILE), PLATE NO. 3.

The river from Black Rock Cañon to White Rock Cañon, a distance of about 31 miles by low-water channel, runs over a stony bed. There are rapids on an average about every 800 feet, and about ten sharp bends.

At the lowest stage it has a width of from 80 feet to 500 feet, and a depth of from 1 foot to 4 feet, except over rapids, where it is from one-half of a foot to 1 foot deep.

The range between low and ordinary high stages is from 3½ feet to 5½ feet, but it sometimes rises above this, flooding portions of the valley.

The slope is about 8 feet in the mile. The banks, as a rule, are almost perpendicular; they are stony up to 4 feet from the lowest stage, above this they are composed of a light sandy soil. At high stages the river spreads over a considerable width, being in places one-half a mile wide.

This high-water channel is well defined by its stony surface, the soil having been washed off and the stones leveled down.

The width of the valley is from 2 to 6 miles. The river through this valley changes

its channel but little. The limits of territory subject to inundation during extraordinary high stages are ill defined.

The Chama River comes in from the west, carrying a large amount of sediment; The Santa Cruz and San Ildefenso creeks from the east. At the time of examination the Chama River was 35 feet wide and 2 feet deep. A pile-wagon bridge crosses the river at San Juan and an iron-truss wagon-bridge at Espanola.

A large number of acequias are supplied with water from the river.

There is no timber and but little brush.

DIVISION NO. 3 (35TH TO 60TH MILE), PLATE NO. 4.

The river here flows for a distance of 25 miles through White Rock Cañon. It has a width of from 40 feet to 220 feet and a depth of from 2 feet to 7 feet, except over the rapids, where it is only half a foot to 2 feet deep.

The fall could not be ascertained throughout. Where measured it was found to be from 26 feet to 52 feet in the mile.

The range between low and ordinary high stages is about 8 feet.

The river for the first 10 miles is bounded by steep hills of rock imbedded in clay, which rise in quick succession back to the perpendicular face of the cañon. Through the other 15 miles there is but a steep incline, probably formed of débris fallen from above, which slopes up to the perpendicular rock, while in a few places the river is bounded by a perpendicular wall.

There are rapids about every 600 feet and about thirty-eight sharp bends; also some bowlders in the channel.

One iron-truss railroad bridge crosses the cañon.

Seven arroyas come in in the east; Rio Frivoles and eight arroyas on the west side, three of the latter through small cañons.

This cañon is 800 feet deep and has a broken country on each side.

DIVISION NO. 4 (60TH TO 83D MILE), PLATES NOS. 5 AND 6.

From White Rock Cañon to San Felipe the river runs through a valley one-half to 3 miles wide for a distance by low-water channel of about 23 miles.

At low stage of river the height of the banks is from 4½ feet to 10 feet, usually the former, and it has a width of from 150 feet to 310 feet. In many places it divides into a number of branches.

During ordinary high stages the river has a width of from 200 feet to three-quarters of a mile.

The depth at lowest stage is from 1½ feet to 3½ feet, except over rapids, where it is from half of a foot to 1 foot deep.

The range between low and ordinary high stages is from 3½ feet to 5 feet.

There are slight rapids on an average every 800 feet, and about ten sharp bends.

The banks are almost perpendicular, and are composed of small stones with a layer of light sandy soil on top. They are stable up to the height of the stone, which is 3½ feet above lowest stage at the mouth of White Rock Cañon, and gradually decreases in height till it disappears entirely at San Felipe.

The fall is from 5 feet to 7 feet in the mile. Between San Domingo and San Felipe, a distance of about 10 miles, a large portion of the valley is subject to overflow.

Eight arroyas and one creek come in from the east, and one arroya from the west.

A large number of acequias are supplied with water from the river.

DIVISION NO. 5 (83D TO 192D MILE), PLATE NO. 7.

From San Felipe the river runs through a valley from 1 to 7 miles wide to a point 6 miles below La Joya, a distance of about 109 miles by low-water channel.

Sand-bars are numerous in this portion of the river, dividing it at places into several channels; near San Felipe there is a continuous shoal down the center of the stream.

The width of the low-water channel is from 150 to 800 feet, and the depth from 1 foot to 6½ feet.

The range between high and low stages is from 2½ feet to 4 feet.

At ordinary high stages the river has a width of from 800 feet to 1½ miles.

The banks are unstable, being composed of a light, sandy soil.

There are no decided rapids in this portion of the river, but the velocity of the current varies very much in different places.

There is a considerable quantity of brush and cottonwood timber along the banks of the high-water channel.

The Rio Jemez comes in from the west through a small cañon. It was almost dry, however, at time of examination. There are also three large arroyas.

Two pile wagon-bridges cross the river on this division, one at Bernalillo and the other at Albuquerque, and a Howe truss railroad-bridge of six 100-foot spans crosses near Isleta.

DIVISION NO. 6 (192D TO 197TH MILE), PLATE NO. 8.

From 6 miles below La Joya to San Acacia, a distance of 5 miles, the river flows through hills, which in some places form cañons, and at others spread out, leaving valleys on one or both sides.

The high-water channel is from 100 feet to 1,500 feet wide. At low stage it has a width of from 200 feet to 800 feet, and a depth of from 2 feet to 4 feet; usual depth 3 feet.

The range between low and ordinary high stages is about 3 feet.

The banks are stable through the cañons, being composed of solid rock, or a mixture of stone, gravel, clay, and sand; along the valleys they are of a light, sandy soil, and consequently unstable.

Three small arroyas come in on the east, and one large one on the west. The town of La Joyeta, situated in a valley on the east side, has been deserted through fear of the encroachment of the river.

There are three sharp bends on this division.

DIVISION NO. 7 (197TH TO 259TH MILE), PLATE NO. 9.

From San Acacia to San Marcial, a distance by low-water channel of about 62 miles, the river runs through a valley from three-quarters of a mile to 3 miles wide, and has a width at low stage of from 200 feet to 600 feet, usual width 400 feet, and a depth from 2 feet to 6 feet, usual depth 3 feet.

The banks are almost perpendicular, and are unstable, being composed of light, sandy soil; these are from 3 feet to 4 feet high.

The range between low and ordinary high stages is 2½ feet to 3 feet.

The fall is about 4 feet in the mile.

The width of river in ordinary high stages varies from 400 feet to 1½ miles.

The low-water channel has about twenty-seven sharp bends.

Nine arroyas come in from the east and eight from the west.

There are five spans of an unfinished wagon-bridge at Socorro, and three spans of a Howe-truss railroad and wagon bridge at San Antonio. Below San Acacia seven large cottonwood trees stand in the present channel. There is a great deal of small timber along the high-water banks.

DIVISION NO. 8 (259TH TO 333D MILE), PLATES NOS. 10 AND 11.

NOTE.—Twenty-two miles below San Marcial the river rose 5 inches during a storm which had lasted three days.

From San Marcial to Palomas the river runs for a distance of 74 miles, by low-water channel, through a succession of valleys and open cañons; the former from 1½ to 3 miles, the latter from 150 feet to 1,200 feet wide. The width of the river at low stage is from 150 feet to 600 feet, and the depth from 2 feet to 5½ feet.

The range betwen high and low stages is 2½ feet to 3 feet, except where narrow passes cause a gorge and consequently a rise of water for a considerable distance back.

The width at ordinary high stages is from 150 feet to three-quarters of a mile.

In the valleys the banks are almost perpendicular and are unstable, being composed of a light, sandy soil. They vary in height from 3 feet to 6 feet. The sides of the cañons are composed principally of stone and gravel, mixed with clay or sand. About 30 per cent. of the banks on this division are of the latter kind. There is a large quantity of good sand-stone, but no brush or large timber.

A great amount of drift has been deposited on the sand-bars, and a few snags obstruct the channel. Two small rock-islands also stand in the channel.

There are about forty sharp bends in the low-water channel.

In a few places the bed of the river was found to be gravel.

DIVISION NO. 9 (333D TO 382D MILE), PLATE NO. 12.

From Palomas to Rincon, a distance by low-water channel of about 49 miles, the river flows through a valley one-half mile to 3 miles wide.

The width of the river at low stage is 70 feet to 400 feet; usual width, 180 feet; and the depth from 1½ feet to 5½ feet.

The range between low and high stages is about from 3 feet to 4 feet.

The width of the river in ordinary high stage is from 200 feet to 1 mile. The banks are almost perpendicular, and, being composed of a light, sandy soil, are unstable,

although protected to some extent by a dense growth of brush and small timber. Their usual height is from 4 feet to 6 feet, but in some places they are 14 feet high.

There are seven small tributaries entering the river from the west. Of these the only two not dry at time of examination were Rio Animas and Rio Frio.

Five arroyas from the east and two from the west also come in here.

A Howe-truss railroad-bridge crosses the river near Rincon.

There is a large quantity of drift on the bars and about seventeen sharp bends in the low-water channel.

A belt of cottonwood timber lines each side nearly all the way down.

DIVISION NO. 10 (382D TO 448TH MILE), PLATES NOS. 13 AND 14.

Rincon to opposite Mesquite, a distance by low-water channel of 66 miles, the river flows principally through valley which has a width of from one-half mile to 6 miles. It is from 200 feet to 800 feet wide at low stage; usual width about 300 feet. Its depth is from 2 feet to 6 feet; usual depth 3 feet.

The range between present and ordinary high stages is 2½ feet to 3 feet.

The width of river at ordinary high water is from 250 feet to 1 mile. The banks are almost perpendicular, are composed of light sandy soil, and have a height of from 2 feet to 5 feet; usually 4 feet.

Below Fort Selden there is about 10 miles of open cañon (sketch 13, plate No. 13). The river here has a width at low stage of from 100 feet to 400 feet, and a depth of from 2½ feet to 6 feet.

Seventeen arroyas come into this division—eight from the east and nine from the west. There are about twenty sharp bends in the low-water channel.

DIVISION NO. 11 (448TH TO 511TH MILE), PLATE NO. 14.

The river from opposite Mesquite to the pass above El Paso, a distance by low-water channel of about 63 miles, has a very tortuous course.

Its width, except in some few places, is from 100 feet to 200 feet, and its depth from 3 feet to 5 feet; usual depth 3½ feet.

The range between low and ordinary high stages is about 3 feet to 4 feet.

The banks are unstable, but strengthened to some extent by a dense growth of brush and trees. They, as a rule, are from 3 feet to 5 feet above the present stage, but in a few places are as low as 2 feet, and in others reach to a height of 10 feet.

The width subject to overflow where the banks are low could not be ascertained.

One arroya comes in on the west. There are about twenty sharp bends.

DIVISION NO. 12 (511TH TO 517TH MILE), PLATE NO. 15.

The pass above El Paso consists of a small cañon about 5½ miles long, with a width of from 500 feet to 1,200 feet.

The width of the river at low stage is from 100 feet to 400 feet, and its depth from 2 feet to 5½ feet.

One arroya comes in from the east and one on the west. There is a stone dam, making a fall of about 4 feet, a short distance above El Paso, and a Howe-truss bridge at the northern end of the cañon.

The valleys through which the Rio Grande flows are very fertile, except in some localities where there is much alkali in the ground.

The water from the Rio Grande carries a large amount of sediment, which is deposited on the land irrigated by it and which is said to contain many fertilizing properties. Only a small portion, however, of the valley is under cultivation, notwithstanding that produce brings high prices.

Above Rincon, where the supply of water has as yet been sufficient, this can only be accounted for by the non-progressive spirit of the Mexican population and by the want of legislation providing for the condemning of the right of way for irrigating ditches.

Below Rincon the supply is sometimes insufficient.

There are a large number of scattered adobe villages along the valley, but only 8 towns of any importance; these are as follows:

Bernalillo, a prospereus town of 1,800 inhabitants, principally consists of 1 street, 2 miles long. It exports large quantities of wine and fruit, also some wool.

Albuquerque, a city of 8,000 inhabitants, has an extensive wool trade, exporting 2,500,000 pounds in the year. It consists of Old and New Albuquerque; the former built of adobe, the latter principally of brick. Exports go north; the imports come both from the north and south.

Socorro, a town of 400 inhabitants, is the center of a rich mineral country, with fifty-three mining districts and extensive smelting works. The mineral production of Socorro County amounts to $3,000,000 annually; the railroad business to $720,000.

San Marcial is a railroad town of about 1,200 inhabitants. It has a very little export trade.

New San Antonio, a town of about 200 inhabitants, has extensive coke ovens. A branch of the Atchison, Topeka and Santa Fé Railroad runs from here to the Carthage Coal Mines. There are limestone quarries 6 miles east of the town.

Las Cruces and Mesilla, two towns about 1 mile apart, have a population of 2,500 and 1,500, respectively. They are a mixture of adobe and modern buildings. The country around them is very fertile, and a large amount of farm produce is shipped away, principally to the North.

El Paso, a city of about 10,000 inhabitants, has extensive smelting works. It also has a large meat trade. Imports to the value of $3,000,000 a month come through its custom-house. Exports to the value of $1,500,000 go out. The imports are principally gold and silver ores and bullion.

The population of the valley from Embudo to El Paso is about 47,000, exclusive of Indians. It is principally Mexican, except in the town, where there is a large white population. This does not include the town of El Paso.

The river is paralleled by the Denver and Rio Grande Railroad from Embudo to Espanola; by the Texas, Santa Fé and Northern from Espanola to White Rock Cañon; by the Atchison, Topeka and Santa Fé from San Felipe to El Paso. There are no other railroads projected.

The people of the valley take no interest in the question of navigation of the Rio Grande, but the problem of how to store its waters for irrigation purposes is one which they consider of vital importance to the prosperity of that section.

In conclusion, I will say that I consider the construction, not only of an open river channel, but of any navigable channel, to be impracticable. There is a high stage of water in the river during the months of May and June, when the current must in many places, especially in the cañons, become almost a torrent. In the valleys this is caused not only by the increased volume of water, but also by a shortening of the channel where it cuts across the sand-spits around which it winds during low stages. During the greater part of the year, when the river is low, the discharge would be insufficient to supply any navigable channel, except perhaps a narrow canal with locks, the construction of which on a foundation of sand, in places 40 feet deep, would be financially, if not physically, impracticable.

Very respectfully, your obedient servant,

GERALD BAGNALL,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

V 10.

PRELIMINARY EXAMINATION FOR REMOVAL OF RAFT ON GAUDALOUPE RIVER, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., January 16, 1889.

SIR: I have the honor to report that, under the instructions contained in your circular letter of August 28, 1888, a preliminary examination has been made "for removal of raft in Guadaloupe River," Texas. It was made by my assistant, Mr. R. B. Talfor, whose report is hereto appended.

An examination of the Guadaloupe River was made under the direction of Capt. C. W. Howell, Corps of Engineers, in 1874. (See Annual Report Chief of Engineers, 1875, Part I, page 924.) At that time there were four rafts, the first one beginning about 12 miles below Victoria, or 41 miles from the mouth, completely blocking the river for a distance of 1,850 feet, and partially obstructing it for a distance of some 1,200 feet more. The second raft began about 14 miles from the mouth, and was in two sections, measuring in all about 1,000 feet in length. The third was about 1 mile below the second, and was also in two sections, measuring altogether about 1,700 feet in length. The fourth and last was near the mouth, and was in five sections. It occupied a little less than a mile of the river, one-half of which was raft, the other half being open space between the sections.

The recent examination shows the upper raft to have increased in dimensions. Its head is about 1¼ miles further up-stream than in 1874. It covers about 1½ miles of the river, and is broken into 8 sections, ranging from 200 feet to 3,000 feet in length.

The up-stream part is composed mostly of loose drift, with an occasional jam of large trees. The lower and middle sections appear to be wedged in from bank to bank, and have a growth of willows and cottonwoods upon them. The removal of this raft would require special appliances, such as a snag-boat, steam saws, and explosives as in the case of the Red River raft. The other rafts were not visited, for reasons given in Mr. Talfor's report, but it was learned that they had been considerably broken up by the storms of 1886, and that their removal presented no great difficulties. Mr. Talfor roughly estimates the cost of removing the first raft at about $30,000, and of the three others at $12,000, making $42,000 in all.

There is at present no commerce upon the river of any kind. Prior to 1854 it was navigated by vessels drawing from 3½ to 4½ feet, up to Victoria. It is thought by some that a portion of that trade would be restored if the river were improved. The Southern Pacific Railway Company now has a branch running northeast to Rosenburg, another running northwest to Cuero, and is building one running west to Beeville, at all of which points connection is made with the general railway system of Texas. Victoria is also connected by rail with tide-water at Lavaca, about 30 miles distant. The Guadaloupe empties into Mission Bay, in which the depth is from 2 to 4 feet, the distance out to 4 feet depth being about 1½ miles. Mission Bay connects with San Antonio Bay, which extends southward about 15 miles to Matagorda Island, by which it is separated from the Gulf of Mexico. The distance from the mouth of the Guadaloupe out to 6 feet depth is about 7½ miles. San Antonio Bay connects on the east and west with other shallow bays, as will appear by an examination of Coast Survey Charts Nos. 108 and 109. There is no town upon San Antonio Bay or either of the adjoining bays. The nearest outlet to the Gulf would be at Pass Cavallo, about 35 miles distant. To provide a channel to this outlet would involve dredging through Mission Bay into San Antonio Bay, and through the shoals which separate San Antonio from Espiritu Santo Bays and the latter from Matagorda Bay. The cost of this may be roughly estimated at about $150,000. The cuts between the bays might, perhaps, maintain themselves, but the channel from the mouth of the river through Mission Bay would probably require annual expenditure for maintenance, the amount of which there are no data for estimating. It is not probable that much, if any, of the former trade of the river would return to it, unless all of the rafts were removed and an outlet provided through San Antonio Bay and adjoining bays, and in view of the increased railway facilities, it may be doubted whether any considerable portion of it would return even with such outlet provided.

The removal of the rafts upon Guadaloupe River would be of benefit to the adjoining country by facilitating the discharge of floods, but it does not appear that commerce would be affected favorably to such an extent as to justify the expenditure. It is, therefore, my opinion that the improvement is not one worthy to be undertaken by the General Government in the interest of commerce.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 9, 1888.

SIR: In accordance with your letter of the 18th ultimo, in which you placed me in charge of "Examination for removal of raft on Guadaloupe River," Texas, I beg leave to submit the following report:

Owing to the bad weather from October 19 to the 21st, and from information received from Victoria stating that the roads were in a very bad condition, and the river high, my departure was delayed until Sunday, October 28, reaching Victoria at 3.45 p. m. the same day. I called on Mr. G. A. Levi, banker, who assisted me in making preparations for an early start the following morning to examine the first raft, the head of which is about 8 miles (by river) below Victoria. Mr. J. A. Heath, with an ambulance and team, was engaged for the purpose.

Monday, October 29, I left Victoria at 9.30 a. m., accompanied by Hon. E. D. Lynn and Mr. William Rupley, on horseback, who were thoroughly acquainted with the country, and arrived at the raft at 1 p. m. Owing to the recent heavy rains the bottom lands in this vicinity were covered with water, and in some places a perceptible current was observed due no doubt to the raft damming the river above. This raft, now covers an area of river of about 1¼ miles in length and is broken into 8 sections, ranging from 200 feet to 3,000 feet in length. The head is now about 1½ miles further up the stream than in 1874. (See tracing of chart of 1874 accompanying.)

The lower and middle sections of this raft appear to be wedged in from bank to bank with a growth of willows and cottonwood on it, in places forming "Tow Heads," similar to those found on the Red River raft above Shreveport, La. The upper part is composed mostly of loose drift, with an occasional jam of large trees. About 1,000 feet of the lower end of the raft has broken or washed away, leaving the present end 1,000 feet farther up stream than in 1874.

I returned to Victoria by 7.30 p. m., and engaged Mr. J. T. Southwell with ambulance to go to the mouth of the river the following morning.

Tuesday, October 30, I left Victoria at 8 a. m., and arrived at the ranch of Col. N. C. Gullett at 7 p. m., 38 miles from Victoria, when we put up for the night.

Wednesday, October 31, I left the ranch of Colonel Gullett with a party of four on horseback, with Colonel Gullett as guide, for the mouth of the river.

After proceeding about 5 miles we met a Mr. Duncan, who lives between the mouth of the river and Hynes Bay, and who informed us that the bayous were "swimming and his bridges carried away," he having to swim his horse across Muddy and Dubolse bayous; that to get to the raft was impracticable on account of the water; also that the raft near the mouth had been very much broken up by the storm of August, 1886, at which time the river being high and meeting of the waters of the gulf and bay broke up and disintegrated the solid parts of the raft, and at the present time its removal could easily be accomplished, this information corroborating that of Messrs. Duboise and McFadden, both gentlemen having large landed interests in that section, east and west of the river. The latter gentlemen informed me that the rafts between the 141st and 143d miles (see chart) had also been greatly broken up by the rain-storm, and but little accretion had taken place, as the first raft caught the drift. This information from reliable sources being deemed sufficient, the attempt to reach the lower raft was abandoned, and we returned to Victoria by 10 p. m., having ridden 90 miles in two days.

Obstructions to navigation are the rafts between Victoria and Mission Bay (the present mouth of the river). The lower rafts in their condition can be easily removed, but the upper or first raft, 8 miles below Victoria, would require snag-boats with steam-saws, similar to those used in removing the Red River raft.

The material of which it is composed must be loosened by the aid of explosives and cut into lengths of, say, from 15 to 20 feet long and run into the sloughs and old "cut-offs." The middle raft can be disposed of in like manner.

The rafts near the mouth need not be disturbed, for the following reasons: The approach to its mouth through Hynes Bay around to Mission Bay is about 15 miles of shallow water, averaging from 2½ to 4 feet, but by cutting a channel through from above the head of the lower raft to Hynes Bay, a distance of three-fourths of a mile, the raft would be utilized as a dam and the water thereby directed through this cut. Vessels of 4 feet draught would save a distance of 12 to 15 miles in entering the river. The line of this canal is approximately indicated on the tracing herewith.

The length of the various rafts are as follows: No. 1 raft, about 1½ miles long; No. 2 raft, about 1,400 feet long; No. 3 raft, about 1,000 feet long; No. 4 (near the mouth), about 1,000 feet long.

APPROXIMATE COST OF REMOVAL.

Rafts No. 2, 3, and 4, 3,400 feet	$12,000
Raft No. 1, 6,600 feet	30,000
Total	42 000

ESTIMATED COST OF CUTTING A CANAL FROM THE RIVER TO HYNES BAY.

One hundred feet wide at the bottom, 8 feet deep, 4,000 feet long, 150,000 cubic yards, at 30 cents per cubic yard	$45,000
Removing rafts Nos. 1, 2, and 3	38,000
Total	83,000

At present there is no commerce whatever on the river, but previous to and up to 1860 several small steamers were engaged in the carrying trade, besides the towing of lumber vessels.

It is claimed that with the river opened to navigation this trade could again be established, especially in lumber. Vessels could then not only go to Victoria, but to the country west of it, *via* the San Antonio River. The value of the commerce of the river previous to 1860 could not be ascertained.

The inclosed letters of Messrs. G. A. Levi & Co., bankers, and Mr. B. M. Temple state what the amount of commerce would be if the rafts were removed, and to which attention is respectfully invited.

In conclusion I would state that I am indebted to Messrs. G. A. Levi & Brownson, bankers at Victoria, and to Hon. E. D. Lynn for information received and courtesies shown.

Inclosed please find vouchers covering the expenses of the examination, as follows:

* * * * * * *

Very respectfully, your obedient servant,

R. B. TALFOR,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

V 11.

PRELIMINARY EXAMINATION OF THE MOUTH OF CANEY CREEK, TEXAS, WHERE IT EMPTIES INTO MATAGORDA BAY.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., January 14, 1889.

SIR: I have the honor to report that under the instructions contained in your circular letter of August 28, 1888, a preliminary examination has been made of the "mouth of Caney Creek where it empties into Matagorda Bay," Texas. It was made by my assistant, Mr. R. B. Talfor, whose report is hereto appended.

A survey for connecting inland waters along the margin of the Gulf of Mexico was made under the direction of Capt. C. W. Howell, Corps of Engineers, in 1874. The inclosed tracing, which covers the mouth of Caney Creek, has been extracted from sheet 5 of the maps of that survey. The following is quoted from the report: "Caney Creek is a sluggish stream, about 300 feet wide near its mouth, that once emptied into the Gulf of Mexico, but about twenty years ago (written in 1875) a small ditch 2,850 feet long was dug, connecting it with Matagorda Bay. This small ditch has since enlarged and deepened, until it now goes by the name of 'The Big Canal'—80 feet wide by about 15 feet deep—through which Caney Creek debouches, and its former outlet into the gulf is completely obliterated." (See Annual Report Chief of Engineers, 1875, Part I, page 898.)

The recent examination covered Matagorda Bay for about 1 mile from the mouth of the canal, the canal, and the creek itself to a distance of about one-third of a mile above where the canal leaves it. The least channel depth found in the creek was 6 feet, and that in the canal 9 feet. The bay was found to have shoaled from 1 to 1½ feet since 1875.

Its depth is now about 2 feet. The recent soundings are shown upon the tracing in red ink. To reach a depth of 4 feet in Matagorda Bay will involve the excavation of a channel to a distance of from 1½ to 2 miles from the mouth of the canal. Mr. Talfor roughly estimates this to cost about $30,000 for the shorter distance. It is probable that an annual expenditure would be required to maintain the channel after the completion of the original excavation. There are no data for estimating what the cost of maintenance would be.

The present commerce of the creek is reported to be "a few light-draught sloops that run at irregular intervals engaged in carrying wood and hides to Lavaca." No figures are given as to the size and number of these vessels, but it is inferred that they are very small, from the fact that during the latter half of the year 1887, when a record was kept under the direction of this office of all the water trade of Lavaca, no vessels were reported to have arrived from or departed to Caney Creek. The Lower Caney country is principally devoted to stock-raising. Upon the Upper Caney about 800 or 900 bales of cotton and some sugar, corn, etc., are produced, which are hauled to stations upon the Texas and Mexican and the International and Great Northern railways. Mr. Talfor considers it doubtful whether much of this trade would be diverted to Caney Creek, if improved.

In view of the probably considerable cost of the improvement, its want of permanence, and the small amount of commerce, present or prospective, to be benefited thereby, it is my opinion that the mouth of Caney Creek is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 14, 1888.

SIR: On my return to Victoria, after making an examination of the raft on the Guadaloupe River, I proceeded overland to Lavaca Thursday, October 31, when I engaged a sloop with two men, and arrived at the mouth of the creek at 11.30 p. m., November 1. The following morning a zigzag line of soundings was run from a point about one-third of a mile above where the canal leaves the creek, and through the canal into Matagorda Bay for about 1 mile from its mouth (see sketch inclosed).

The soundings show that the eastern extremity of the bay has shoaled from 1 to 1½ feet since 1875, in which year, during the cyclone of September 15 to 17, a cut was made from the bay to the gulf through Mitchell's Bayou. The shoaling is no doubt due to the gulf sands being carried through this cut into the bay.

The channel into the canal from the bay is now near the north shore, with a minimum depth of 2½ feet in it, while in 1874 the channel was about one-half a mile further south.

The least depth of water found in the creek was 6 feet; in the canal 9 feet.

COMMERCIAL.

Previous to 1861 or 1862 the following vessels were engaged in the Caney Creek trade: Steamers *Cora*, *Lucy*, and *Gwyn*, with a carrying capacity of about 1,000 bales each; schooner *Lake Austin*, 50 tons, and various small crafts of from 5 to 20 tons. These boats used to run to Hawkins Drawbridge, 25 miles above the mouth of the canal.

At present there are only a few light-draught sloops, that run at irregular intervals, engaged in carrying wood and hides to Lavaca.

For the production of the country I will refer you to inclosed list, for which I am indebted to Mr. Selkirk, treasurer of Matagorda County.

It is doubtful whether much of this trade would be diverted to the creek were it made navigable for vessels of light draught, as there are other impediments to navigation in Matagorda Bay, which would render it an uncertain means of communication.

The lower Caney country is principally devoted to stock raising. The products of the upper Caney consist of sugar, cotton, corn, etc., which is hauled to Wharton, a station on the line of the Texas Mexican Railroad, or to Brazoria or Columbia, on the Brazos River, the latter town being at the terminus of a branch of the International and Great Northern Railroad.

Probable cost of dredging a channel 100 feet wide by 2 feet by 7,920 feet long, 58,666 cubic yards, at 50 cents per cubic yard, $29,333.

Very respectfully, your obedient servant,

R. B. TALFOR,
Assistant Engineer.

Major O. H. ERNST,
Corps of Engineers, U. S. A.

STATEMENT OF MR. SELKIRK, TREASURER OF MATAGORDA COUNTY, TEXAS, OF THE PRODUCE OF THE LANDS BORDERING ON CANEY CREEK, TEXAS.

J. T. Sargent, ranch supplies and wood; Jacob Smith & Sons, ranch and farm; A. C. Bruce, farm; Vincent Hurd, farm, corn, wood, etc.; Henry Freeman, farm, corn, wood, etc.; W. T. McNeel, farm, 10 bales; J. F. Nuckols, farm and ranch, corn, cedar wood, etc.; J. S. Sanborn, farm, 25 bales; J. B. Hawkins, sugar farm, last crop 400 hhds., and molasses, besides some cotton, has about 1,200 acres under fence; Ewing Place, farm, 100 bales; Wells Thompson, farm, 200 bales; C. H. Williams, farm, 50 bales; H. W. Bowie, farm, 150 bales; P. M. Bowie, farm, 150 bales; Capt. J. K. White, farm, 150 bales; Ira Spencer, farm, 35 bales, corn and supplies, and ranch; Wm. Bell, farm and ranch, corn, fruit, etc.

River steamers *Cora*, *Lucy*, *Gwyn*, average 1,000 bales each; schooner *Lake Austin* about 50 tons; various small craft from 5 to 20 tons, used to run to Hawkins Drawbridge, about 25 miles. Dog Island Reef, about 1,800 feet across, with 3 feet of water at present.

Upper Caney's products go to Wharton and Brazoria.

APPENDIX W.

IMPROVEMENT OF RED RIVER AND OF CERTAIN RIVERS IN THE STATES OF ARKANSAS AND TEXAS, AND OF CERTAIN RIVERS IN THE STATES OF LOUISIANA, MISSISSIPPI, AND TENNESSEE, TRIBUTARY TO THE MISSISSIPPI—WATER-GAUGES ON THE MISSISSIPPI AND ITS PRINCIPAL TRIBUTARIES.

REPORT OF CAPTAIN JOSEPH H. WILLARD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Red River, Louisiana and Arkansas.
2. Cypress Bayou, Texas and Louisiana.
3. Ouachita and Black Rivers, Arkansas and Louisiana.
4. Ouachita River, Arkansas, above Camden.
5. Bayou D'Arbonne, Louisiana.
6. Little River, Louisiana.
7. Bayou Bartholomew, Louisiana and Arkansas.
8. Bayou Bœuf, Louisiana.
9. Tensas River and Bayou Macon, Louisiana.
10. Bayous Rondeway and Vidal, Louisiana.
11. Big Black River, Mississippi.
12. Yazoo River, Mississippi.
13. Tchula Lake, Mississippi.
14. Tallahatchee River, Mississippi.
15. Steele's Bayou, Mississippi.
16. Big Sunflower River, Mississippi.
17. Big Hatchee River, Tennessee.
18. Forked Deer River, Tennessee.
19. Water-gauges on the Mississippi River and its principal tributaries.

EXAMINATIONS.

20. Bogue Phalia, Mississippi, especially the part known as the Narrows.
21. Bayou Dorcheat, Louisiana, from Lake Bistenau to the Arkansas line.
22. Ouachita River, Louisiana and Arkansas, from its mouth to head of navigation, to determine the advisability and probable cost of its permanent improvement.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., July 1, 1889.

GENERAL: I have the honor to transmit herewith annual reports upon works of river improvement in my charge for the fiscal year ending June 30, 1889.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

W 1.

IMPROVEMENT OF RED RIVER, LOUISIANA AND ARKANSAS.

Red River has its headwaters in northern Texas and flows in an easterly direction, forming the boundary line between Indian Territory and Texas. At Fulton, Ark., it changes its course to a general southeasterly direction, and, flowing through Louisiana, enters the Mississippi at Red River Landing. The portion within this district extends from Fulton, Ark., to the mouth of Atchafalaya River, about 525 miles.

The improvement of Red River was begun by the United States as early as 1828, and more than $500,000 were appropriated and expended between 1828 and 1852. No appropriation was made between 1852 and 1872, during which time the results of former work were lost.

The present improvement was begun in 1872. The project contemplated the removal of snags and other obstructions; closing Tone's Bayou Outlet, which depletes the main channel below as far as Grand Ecore, where the water, diverted through the outlet, re-enters the river, opening a channel through the falls at Alexandria, La., and deepening the channel at shoal places; to improve and keep navigation open from Fulton to the mouth of the Atchafalaya. No estimate for permanent improvement can be presented, as new obstructions are added continually by caving banks, etc., and each flood brings down large quantities of drift from the upper river, the removal of which requires that the work be carried on from year to year.

The protection of the harbor at Alexandria, La., by means of a wing-dam and training-wall is included in the project for this improvement.

The work from 1872 to the end of the fiscal year 1887–'88 benefited navigation greatly. The great raft had been removed, opening more than 200 miles of river above Shreveport to navigation. By means of snag-boats and shore parties large quantities of obstructions were destroyed annually, the raft prevented from reforming, and the river kept open from Fulton to the mouth of Atchafalaya River, being navigable between those points almost the entire year. Several ineffectual attempts were made to close Tone's Bayou, but nothing has been done since early in 1882, when the dam under construction was destroyed. The channel excavation at the falls of Alexandria was completed practically in 1885, and a dam and training-wall for protecting the banks from erosion by the current were built the same year.

Prior to 1878 no work was done towards removing obstructions from the river below Shreveport, La., the appropriations being for opening a channel through the raft and closing Tone's Bayou. A faint idea of the immense quantities of snags, etc., obstructing navigation of this river can be gained by reference to the lists of obstructions removed, published in preceding reports.

The work performed had the effect of reducing insurance and lowering freight rates, besides improving navigation, diminishing the risks thereof, and shortening the time of delivery. The country bordering the river is fertile, and as the improvement advances will be developed correspondingly, and commerce and navigation probably increased largely.

At the close of operations of 1887–'88 the river was less obstructed than it had been for years, but a vast amount of work remained undone. The river-bed in the old raft region, above and below Shreveport, is a mass of sunken logs, and a constant menace to low-water navigation. Some of these are washing loose continually, and become

dangerous snags. Others, thoroughly water-logged, remain at the bottom, causing rapid deposits of sediment and forming impassable bars. The banks of the upper river for hundreds of miles are heavily timbered, and, the alluvial soil being incapable of resisting a rapid current, each freshet causes them to cave and slide, taking the heaviest trees into the stream. The amount of timber thus contributed is enormous, and during high water forms jams or rafts, which require immediate removal. The limbs and roots of green trees need considerable depth to float them, and as the water falls many are stranded on bars and shoals, becoming new obstructions to navigation. Caving banks leave dangerous shore snags projecting far out into the river, which are a continuous trouble, and should be cut after every rise and fall.

Operations of the past fiscal year have been as follows:

GENERAL IMPROVEMENT.

The work of repairing the plant was begun in September, soon after official notification of the act of August 11, but snagging operations were delayed by various causes until December.

Under authority of the Chief of Engineers, Captain Taber, Corps of Engineers, on December 16 transferred the hand-propelled snag-boat *Harry Breck* (which had been employed on Red River above Fulton), for temporary use in this district. The transfer was made at Harris Ferry, Tex., and the time from December 16 to 26 was consumed in running to Fulton, Ark. The boat is well suited for light snagging and shore work. Operations were begun at Fulton December 27 and continued until March 9, under superintendence of J. E. Thompson, when the boat was withdrawn on account of high water and laid up with the fleet at Shreveport. The work extended from Fulton down to Long Prairie, Ark., a distance of 60 miles, but was by no means thorough, on account of high stages of the river. The following is a summary of the work performed:

Snags pulled	34
Shore snags cut	16
Side jams removed	16
Leaning trees cut	2,862
Leaning trees topped	614
Leaning trees girdled	2,038

The light snag-boat *Hooker*, Jo M. Muir, master, left Shreveport January 7, for operations in Red River above, and for preliminary trial before sending it to work in Ouachita River and tributaries, for which it was purchased. This boat continued work in the upper river until January 19, and then returned to Shreveport. On the 22d it was sent to Tensas River and Bayou Macon, removing obstructions from Red River on the way. The following summary gives the work performed:

Snags pulled	111
Shore snags cut	113
Logs removed from channel	827
Jams removed	1
Side jams removed	24
Leaning trees cut	27
Leaning trees topped	1

The snag-boat *Florence*, M. B. Lydon, master, was put in commission January 22, and employed until April 12. In compliance with telegraphic instructions from the Chief of Engineers, the dredge *Lone Star* was towed to Waterloo Bend, 25 miles below Shreveport, February 13,

and employed in digging a cut-off through the Waterloo plantation, the right of way having been purchased and excavation commenced by private subscription last summer, for the purpose of carrying off the water more rapidly and relieving adjacent lands from overflow, but not completed before high water set in. The dredge perfomed all the work practicable at the high stage by February 18, and was then towed back to Shreveport, but in March, after the water fell sufficiently, returned and was again employed in widening and deepening the channel. This work was performed by the crew of the *Florence*, and the entire time occupied in getting the dredge ready for service, digging the cut-off, and towing was twenty-two days. * * * A careful survey is now being made of Red River with a view to its permanent improvement, and nothing should be done to the river, except clearing it of obstructions to navigation, until that survey is finished and plans called for discussed and adopted. If it were only a question of draining Red River Valley, cut-offs would certainly expedite the flow, leaving the upper part a rivulet in dry seasons and making it a torrent in the wet months, and drowning the lower valley; and this would continue until by caving banks new bends were formed and the river slowly lengthened out to something like its former condition.

With the exception of the work on the cut-off, and three days in April spent in towing the survey quarter-boat to Fulton, the *Florence* was constantly at work in the river above Shreveport from January 22 to April 15, principally in the old raft region, it being necessary to patrol this part of the river frequently during the high stages to prevent jams of drift. The following is a summary of the work accomplished by this boat during the year:

Snags pulled	number	231
Stumps pulled	do	11
Logs removed from channel	do	1,062
Jams removed	do	9
Side jams removed	do	132
Shore snags cut	do	656
Leaning trees cut	do	1,722
Brush cut from banks	square yards	58,836

The high stages of Yazoo River and tributaries being unfavorable for work, the snag-boat *Meigs*, P. R. Starr, master, was transferred to Red River in February, leaving Vicksburg on the 23d, and reaching Red River Landing on the 25th. Heavy work being needed in the narrow river below Tone's Bayou, the boat proceeded toward this portion of the river as rapidly as possible, removing only the most dangerous obstructions on the way. These consisted chiefly of trees on caving banks or at short points liable to fall in the river. This class of work was continued up-stream to Shreveport, which was reached March 22. After the boat arrived at that place communication was opened with the officers of the St. Louis, Arkansas and Texas Railroad to ascertain if they proposed to remove the train wreck at the Garland Bridge (see Report of Chief of Engineers for 1888, page 1337), the water being high enough to admit the *Meigs* to that point, where she could render material aid in removing the locomotive and débris. Failing to receive a satisfactory reply, the boat left Shreveport March 30 and worked back down stream to Montgomery, about 160 miles above the mouth. From there down the river was too high for effective operations, and the boat came on to Vicksburg, arriving April 28. As an instance of the temporary character of improvements of this stream, I will state that in March, on the way up, the *Meigs* cut all the trees in Cottage Home Bend (about 90 miles below Shreveport) for a distance of 20 feet back from the river,

but on the return found that the bend had caved so rapidly that the portion cleared had gone into the river, and this time all trees in the bend were cut for a distance of 40 feet from the water's edge. The following is a summary of the work performed:

Snags pulled	number..	252
Stumps removed	do....	24
Shore snags cut	do....	113
Leaning trees cut	do....	11,405
Leaning trees girdled	do....	1,023
Brush cut from banks	square yards..	410

June 7 the snag-boat *Howell* left Shreveport for work in the river below, proceeding at once to the stretch above the mouth of Black River known as the Kapions, which was reported by steam-boat men as the most obstructed portion of the lower river. The obstructions consisted chiefly of mud-lumps and stumps, which it was proposed to destroy by means of high explosives; but heavy and continued rains after the 10th caused the river to rise so rapidly that it became necessary to suspend operations on the 19th, and the boat worked back to Shreveport, arriving June 26, and was laid up to wait a lower stage. The following obstructions were removed during the month:

Snags pulled	159
Stumps destroyed	23
Shore snags cut	991
Leaning trees cut	1,600

Operations of the snag-boats during the past year resulted in much benefit to navigation, but were interfered with to a great extent by high stages of the river during a greater part of the time. These high stages, however, while delaying work have kept the river in a good navigable condition, and the majority of the snags being so far under water ceased to be obstructions for the time being. At low water a large amount of work will be needed, as the banks will cave and slide as the water falls, and the snags and stumps in the channel will become dangerous.

In addition to snagging operations, patrolling the river when drift is running, etc., by the snag-boats, the systematic clearing of the banks of brush, leaning trees, and projecting logs should be continued. The work begun by the snag-boat *Breck* should be gone over at a low stage and carried down-stream, clearing up everything by the way and devoting especial attention to the bends. Such work is done most easily during extreme low water, when the depth is too little for snag-boats, and therefore a special boat should be built for the purpose. The cheapest plan would be to build a strong flat with quarters for a chopping party of eighteen to twenty men, with overseer, watchman, and cook. The boat should be fitted with boiler, pump, steam-capstans, and light shears or crane for pulling logs out of the banks as they cave, and removing logs and small snags from the channel. The amount of work of this kind is so great, and the benefit that would result so immediate, that I recommend outfit and equipment for two parties. By such means a large amount of work can be done in one season, and so thoroughly as not to need doing over for many years. There will remain plenty of work of the same kind below Shreveport to employ the boats till they are worn out. The estimates for a single boat and party are as follows:

Boat and equipment	$4,600
Crew, subsistence, explosives, etc., 8 months, at $1,200	9,600
Four months' care at fleet, at $50	200
Repairs and maintenance of outfit, tackle and tools, fuel, etc	600
Total, first year	15,000

Wear and tear in this kind of work is very great, so that the item for repair should be at least double for the second year.

In March, 1887, I sent out circular letters to persons interested in this river, asking for information about wrecks, their position, and the amount of obstruction. Five lists have been sent in, giving names of boats, causes of loss, and specifying those that are still serious obstructions. Comparing these lists I find that in fifty-two years 197 steam-boats have been lost in Red River. One list gives 86 snagged, 21 burned, 11 destroyed during the war, 4 exploded, and 3 destroyed by collisions. Four are reported as more or less in the channel above Shreveport, 2 as obstructing the steam-boat landing, and 1 on edge of channel at Shreveport, 8 as badly in the way, 9 on edge of channel between Shreveport and mouth of Loggy Bayou, a distance of about 100 miles, and 22 as more or less in the channel below Loggy Bayou to the mouth of the river. The most dangerous should be removed first, but any wrecks that tend to cause shoals and eddies should be destroyed. If high explosives are used liberally the work should not be difficult or expensive. No special estimate is made for it, as it falls in the regular work of the boats.

ALEXANDRIA HARBOR.

The law of August 11, 1888, contains the words, "including completing the work at Alexandria," without, however, specifying the character of the work to be done. Captain Bergland reported in 1886 that the channel through the upper falls was practically completed; and also that the project for protection of the harbor had been carried out. I made an examination in 1886, and had a careful survey made of the reach at Alexandria, and recommended that no further work should be done at that place until the completion of the survey of the river from Fulton to the mouth. I repeated this recommendation in my report for 1888, and postponed consideration of the subject for the same reasons in my project for 1889. (Reports of the Chief of Engineers, 1886, page 1340; 1887, page 1445, and 1888, page 1336.) The banks in this reach appear to be stable under ordinary conditions, and there does not appear to have been any dangerous caving on the Alexandria side since the extraordinary storm of June 14–16, 1886, when 28.58 inches of rain fell in forty-four hours, and the river rose 25 feet within two days. The storm was local and its effect on the river was not appreciable for any great distance above.

Recent correspondence with the Hon. N. C. Blanchard, member of Congress from Shreveport, shows that there is a strong desire on the part of certain residents of Alexandria to have the city front protected, but an examination made in May failed to show any caving. When the river falls to a low stage a more extended examination will be made, and the results compared with the surveys of 1886–'87, and of earlier date, and if it shall appear that there is danger lest navigation be impeded or injured, a project will be submitted for the extension of the work executed by Captain Bergland, or for some form of bank protection that shall not involve payment of land damages. Major Miller's project, approved July 26, 1884, contemplated revetting about 3,000 feet of bank, which involved grading back to a slope of about 1 on 3, for which the property owners demanded compensation to an amount nearly one-third the estimate, and this caused the change in the project submitted by Captain Bergland October 24, 1884. The case at Alexandria seems to be like that at Columbus, Hickman, Memphis, Greenville, etc., on Mississippi River, for which special appropriations were considered necessary. None of the places named are harbors.

BRIDGES.

The bridge at Garland has been rebuilt, but nothing has been done as yet toward removing the wreck under the broken span. The railroad company has been put in the hands of a receiver, and litigation is now in progress between him and the bridge-constructing company. There have been no complaints of obstructions in the draw span, but it is reported that the channel is being injured just below by deposits of saw-dust from a mill on the right bank. An examination will be made in low water and the result compared with the survey of 1887, and if the channel should be found impaired steps will be taken to prevent further injury.

The bridge at Shreveport was brought under general control of the United States by act of Congress, March 2, 1889 (Public No. 146), and the company furnished with rules of the Light-House Board for lighting bridges, etc. Since my report on the bar at this bridge (Report of the Chief of Engineers, 1887, page 2672) a careful watch has been kept of its movement and condition. An examination of the river at this place, water about 7 feet on the gauge, was made in November, 1888. The soundings taken, when compared with those of the surveys of 1886 and 1887, showed that the channel was under the west draw-span, and that the former channel under the fixed span had nearly filled up. When the survey party reached Shreveport this season a careful survey was made, to be plotted on the same scale as the others. The map has not been finished, but the notes show that no improvement is required at this point at the present time. There have been no complaints made of lack of depth under the draw span, or of neglect to open on reasonable signals.

No movements have been made by the parties in interest towards selecting sites for the bridges authorized at Alexandria and Natchitoches by the acts of March 3, 1887, August 6, 1888, and March 2, 1889

CYPRESS BAYOU.

The improvement of the water-way between Shreveport, La., and Jefferson, Tex., known as the Cypress Bayou route, has been carried on heretofore under specific appropriations for that work, $112,000 having been appropriated to June 30, 1888. (See Appendix W 2.)

The act of August 11, 1888, allotted the sum of "five thousand dollars, or so much thereof as may be necessary," from the appropriation for improving Red River, Louisiana and Arkansas, for use in continuing this work.

The work remaining to be done on this route under the present plan was straightening the channel through Fairy Lake and removing stumps, etc., and to give greater depth, removing stumps in the channel in Sodo Lake, clearing Twelve-Mile Bayou of snags and leaning timber, and a small amount of dredging at various places, the principal dredging operations contemplated by the project having been completed in 1888.

The work in Twelve-Mile Bayou having been reported by the steamboat men as of first importance, the snag-boat *Howell* was employed in May in clearing this stream, and the following obstructions were removed:

Snags pulled	number	41
Stumps removed	do	56
Shore snags cut	do	885
Leaning trees cut	do	4,493
Leaning trees girdled	do	29
Brush cut	sq. yds.	200

There is never less than 4 feet of water in the bayou, but it is so narrow and the current so swift that navigation through was extremely hazardous before these obstructions were removed, but the master of the steamer *Friendly*, under date of May 25, reported that the work performed had reduced the danger to such extent that he could make the run at night with safety.

On finishing this work the *Howell* was sent to Lower Red River, having accomplished all it could do at the stage of water. As soon as practicable, work in the lakes will be commenced and pushed rapidly forward.

The only thing that can be done on this route under the adopted project is to clear the lines formerly laid out, and called "roads," of brush and stumps, and perhaps a small amount of dredging to give a high-water navigation. To dredge a channel through the lakes. without a dam, as proposed by Major Howell, would serve only to drain the lakes and bayou. The people of Jefferson, and those desirous of reviving steam-boat trade between Jefferson and New Orleans, are very anxious to have deep-water navigation throughout the year. This would involve an expenditure of about $400,000, according to the original estimates for the work, including the dam at Albany Point, in my opinion a sum wholly disproportionate to the benefit that might follow.

Even if it were thought wise to undertake a work of such a character, it would be necessary to make a careful survey of the whole drainage basin between Jefferson and Shreveport, and prepare new plans and estimates, as the reduction of the low-water plane of Red River has caused an entire change of the conditions under which the original project was prepared. I should be unwilling to make such a survey and plans without an appropriation of at least $6,000.

BAYOU DORCHEAT.

The law of August 11, 1888, provided $5,000 of the appropriation for improving Red River, or so much thereof as might be necessary for the improvement of Bayou Dorcheat. A specific appropriation of $5,000 was made for this work by act of July 5, 1884, and the most serious obstructions to high-water navigation between Murrell's Point on the Dorcheat to the mouth of Loggy Bayou, 71 miles below, were removed with this amount. (See Report of Chief of Engineers, 1885, page 1496.)

The present plan is to go over this work, cutting the brush which has grown since 1884, and removing all dangerous stumps, leaning timber, etc. Operations were commenced with the snag-boat *Breck* in the Dorcheat May 21 and continued down-stream to the close of the year, the following summary giving the amount of work performed:

Stumps removed	number..	146
Leaning trees cut	do....	86
Leading trees girdled	do....	14
Willows and brush cut	sq. yds..	258,605

This work will be continued down to Red River, and probably completed early in August.

There has not been a steam-boat over this route in the past four years, but I am informed that arrangements have been made to run a boat during the next high-water season. The facilities offered by railroad transportation to and from Minden, which is the principal shipping point, have diverted all the business of that place from the waterway. The only advantages gained by the improvement are the reduction of railroad rates by competition, and the saving to the people

living below Minden, who now haul their products and supplies from 15 to 25 miles to a shipping point. On completion of the work now in progress nothing further should be required for many years to come. To lengthen the navigable season, dredging of bars and narrow places would be necessary, the cost of which is not commensurate with the limited commerce that would be benefited.

SURVEY OF RED RIVER FROM FULTON, ARKANSAS, TO ATCHAFALAYA RIVER.

The topography and hydrography of this survey had been carried from Fulton to Caspian Landing by March, 1887, and the field-notes put in shape for resuming work when further appropriation should be made.

Shortly after the funds provided by the law of August 11, 1888, became available, operations in this district were suspended by the report of the appearance of yellow fever at Jackson, Miss., and for some time after the quarantine was raised and the panic had subsided it was difficult to secure men to go into the field for continuing the work.

The approved project is briefly as follows:

To connect the survey with that of the Mississippi by a line of precise level from the Coast and Geodetic Survey bench at Delta, La., crossing to Shreveport on the line of the railway, thence up Red River to Fulton, and down Red River to the Coast survey bench at the mouth, setting permanent benches not more than 6 miles apart, and incidentally fixing the low and high water planes of the important tributaries to Red River, such as Ouachita, Tensas, Macon, Boeuf, and the Dorcheat. To review the work from Fulton down-stream setting permanent benches and triangulation stations and carrying tertiary triangulation down-stream to Atchafalaya River, making a close topographic and hydrographic survey, transit, and stadia on the way, and laying out the scheme for secondary triangulation on the return during the second season. To measure the Coast survey base at Delta, La., to standardize the tapes and chains, and subsequently to fix their values by measuring another base of the Coast Survey. To set up gauges, determine high and low water slopes, and carry on current and sediment observations. Work was begun under Assistant Engineer Horace M Marshall, of Vicksburgh, and assistants obtained who had been employed on like work on Mississippi and Missouri rivers. The Vicksburgh and Shreveport Railroad Company, being much interested in the levels from Delta to Shreveport, gave me the use of an engineer's car, and a freight-car for quarters and kitchen for the level parties, and moved the train as the line advanced, thus greatly facilitating the work and charging only for the services of one man, who was sent with a hand-car to move the level parties to and from the train in their daily work. The line of level and permanent benches will be of great value to the people in the secondary valleys between Mississippi and Red rivers in the matter of draining their lands and determining those safe from overflow, and also gives fixed points for reference in surveys and examinations of the tributaries.

The permanent benches are the same as those used in the commission.

SURVEYS.

For range stones and tertiary triangulation stations I used vitrified sewer-pipe about 2 feet long and 4 inches diameter, which are put in the ground, securely tamped, and half filled with sand, the upper half

being filled with sand and cement and holding an iron spike for reference point. This furnishes a cheap and durable monument, light and easily handled.

For base-measuring, an apparatus has been devised by taking the principle of that used in the Missouri River Commission surveys. The suggestion and the modification of some of the mechanical parts were given to Assistant Marshall by me, but the development of the idea is his own. Small brass and steel tapes are used side by side, about 350 feet long by one-eighth inch wide and sixty-four one-hundredths inch thick and stretched under equal tensions by means of weights sliding on balanced beams. The apparatus was made by W. & L. E. Gurley, of Troy, N. Y., who co-operated heartily in making it a success. The temperature corrections can be made without the use of thermometers by using tapes of dissimilar metals, rolled as near as possible to the same gauge, and thus base measuring can be undertaken without waiting for special conditions. The base at Delta, about 2,700 meters long, was measured several times, and after the party was broken in well a measurement was made in about four hours. The work was done at night, when the variations in temperature were slight, and the field computations show a remarkable degree of accuracy. The apparatus is now being modified in some minor parts as found desirable from experience, and when completed will, I am confident, serve as a model for work of this kind. A special report will be made on this subject when the computations shall have been revised.

As was provided for in the project, and as stated in Assistant Marshall's report, it will be necessary to suspend work early in August. The men are beginning to suffer from hard work and exposure in the swamps, and must be given an opportunity to recuperate. Operations will probably be resumed in October, unless prevented by general sickness in the Red River Valley.

Taken as a whole, I have never seen a finer set of young men on any party of the kind than those collected and organized by Mr. Marshall and his assistants.

The following extracts from Assistant Engineer Marshall's report give the details of the progress of the survey to June 30, 1889:

A project was formulated, submitted, and approved during January last. In conformity thereto, a double party consisting of Assistant Engineer T. C. Thomas, Leveler T. G. Rombauer, two recorders, four rodmen, two shade-men, a cook and waiter, was organized at Delta, La., February 13, and quartered on board two cars, the use of which had been courteously tendered by the Vicksburg, Shreveport and Pacific Railroad Company, through Superintendent H. F. Clark.

A line of precise level referred to Cairo datum was run from U. S. Coast and Geodetic Survey bench-mark at Delta, La., to Shreveport, La., with cross-sections of Lake One, Tensas River, Bayou Macon, Boeuf River, Ouachita River, and Bayou Dorcheat. From Delta to Shreveport, 270 kilometers (169 miles) by railroad, along which the level was run, permanent bench-marks were set about 8 kilometers apart. Three of these were copper bolts 3 millimeters in diameter leaded horizontally into the sides of brick buildings; and 43 were pieces of limestone 46 centimeters square and 15 centimeters thick, marked $\overset{\text{U.S.}}{\underset{\text{B.M.}}{\circ}}$ with spherical-headed copper bolts leaded into the middle of the upper face, buried 1.2 meters under ground, and access given through 12-centimeter iron pipe set on top. The pipe has a cast-iron cap cover fastened by a horizontal bolt through cap and pipe. The cap has a small knob and the letters $\overset{\text{U.S.E.}}{\underset{\text{B.M.}}{\circ}}$ raised on top.

After the party had gone as far as Monroe, La., they were returned to Delta to determine accurately the lengths of Red River steel and brass tapes, by measuring a base of the U. S. Coast and Geodetic Survey, the length of which had been ascertained by measurement with a regular base apparatus. The measurements were

made at night; the tape was supported at uniform intervals and stretched under uniform tension by means of a balance-beam having arms at right angles, and scales attached to the tapes near the ends were read by verniers. No final reduction of the measurements has been made, hence no results can be given now, and a description of the base-measuring apparatus designed under your direction is deferred. A preliminary reduction of the notes indicates a very high degree of refinement and nicety of observation.

April 8 a second party, consisting of F. B. French, transitman, E. J. Thomas, leveler, John Hilleke, draughtsman, four rodmen, one recorder, a watchman, ten laborers, and a cook, was organized at Shreveport, and on board a quarter-boat towed by U. S. steamer *Thos. B. Florence* to Fulton, Ark. Mr. T. C. Thomas was transferred from the precise level party and placed in charge of the party at Fulton. The vacancy in the first party was filled by E. T. Washburn, leveler, and the party left in charge of Mr. T. G. Rambauer. From Fulton, Ark., the party went over the survey made during the winter of 1886 and 1887 to Shreveport, La., setting stone and pipe bench-marks and triangulation monuments. The triangulation monuments differ from the bench-marks already described only in the marking, the stones being marked $\overset{\text{U.S.}}{\underset{\Delta}{\circ}}$ and the caps having raised on top $\overset{\Delta}{\underset{\text{E.}}{}}$

Thirty-seven triangulation stones and seventeen bench-mark stones were set between Fulton and Shreveport, the distance by river being 293 kilometers (183 miles).

The party from Fulton reached Shreveport on the 18th of May, and the party from Delta on the 25th, and the combined parties have continued work down the river. Transitman R. S. Buck joined the party June 1.

The survey below Shreveport consists of a tertiary system of triangulation, with stations marked by pieces of 12-centimeter vitrified pipe in sections three-fourths of a meter long, set in the ground and filled with cement, the projecting point of a large nail marking the center; topographical survey of the river and the country on both sides extending back 700 meters; a line of duplicate precise level with stone bench-marks; a continuous line of channel-soundings; river section-soundings about 400 meters apart, and sections running back 700 meters at intervals of 8 kilometers. These sections are marked at the extremities and at the banks of the river by vitrified sewer-pipe filled with cement.

At the present rate of progress, by the end of the fiscal year the survey will have reached a point about 100 kilometers (62.5 miles) below Shreveport.

The health of the party has been good and the progress quite rapid, but, as was anticipated in the project, work in the field will doubtless have to be suspended during August and September, which time will be occupied by assistants in the office making reduction of the field-notes. Field-work will be resumed in October, and the survey continued to Atchafalaya River.

The following amounts have been expended during the fiscal year:

For general improvement, repairs, care of plant, etc	$21,702.32
For Cypress Bayou, etc	1,755.45
For Bayou Dorcheat (including liabilities $7)	1,575.83
For the survey (including liabilities $118.80)	14,041.15
Total	39,074.75

Appropriations aggregating $535,765.50 were made at intervals between 1828 and 1852.

The present improvement dates from 1872, and the following amounts have been appropriated:

By acts of June 10, 1872—	
For improving Tone's Bayou	$20,000.00
For removing raft	150,000.00
By acts of—	
March 3, 1873, for removing raft	80,000.00
June 23, 1874, for removing raft	50,000.00
March 3, 1875, for removing raft	20,000.00
August 14, 1876, for removing raft and closing Tone's Bayou	35,000.00
Allotment August 27, 1877, from appropriation for repair, preservation, extension, and completion of river and harbor works, act	
April 10, 1869, for closing Tone's Bayou	4,500.00
February 7, 1878, for removing raft, etc	6,000.00
June 18, 1878, for removing raft and closing Tone's Bayou	24,000.00
For removing snags and other obstructions	25,000.00

By acts of—	
March 3, 1879, for removing raft and closing Tone's Bayou	$15,000.00
For removing obstructions	22,500.00
For improving upper river from Fulton, Ark., to head of raft	10,000.00
June 14, 1880, for removing raft and closing Tone's Bayou	25,000.00
For removing obstructions	60,000.00
For improving upper river from Fulton, Ark., to head of raft	10,000.00
March 3, 1881, for removing raft and closing Tone's Bayou	10,000.00
For removing obstructions	10,000.00
August 2, 1882, for improving Red River	75,000.00
July 5, 1884, for improving Red River	75,000.00
August 5, 1886, for improving Red River, making survey from Fulton, Ark., to Atchafalaya River, and completing survey of Bayou Pierre, Louisiana	75,000.00
August 11, 1888, for improving Red River, Cypress Bayou, and Bayou Dorcheat	65,000.00
For completion of survey from Fulton, Ark., to the Atchafalaya River	35,000.00
Amount appropriated to June 30, 1889	902,000.00
Amount expended to June 30, 1889	839,232.92

Money statement.

July 1, 1888, amount available		$1,841.83
Amount appropriated by act of August 11, 1888		100,000.00
		101,841.83
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$38,948.95	
July 1, 1889, outstanding liabilities	125.80	
		39,074.75
July 1, 1889, balance available		62,767.08
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		100,000.00

COMMERCIAL STATISTICS.

Navigation of Red River below Shreveport, La., has been uninterrupted during the past year, except for a period of about six weeks of low water, during which time boats ran as high as Alexandria and Coushatta. Eight steam-boats, ranging from 250 to 950 tons, and drawing 1½ to 3 feet light and 3 to 7 feet loaded, were employed in the lower river trade, and made 94 round trips to New Orleans. The following down freights were reported:

Cotton	bales.. 50,375	Rice	sacks.. 130
Cotton seed	tons.. 11,975	Eggs	boxes.. 601
Cotton-seed oil	bbls.. 272	Poultry	coops.. 25
Cotton-seed meal	tons.. 1,722	Peas	sacks and bbls.. 450
Soap stock	bbls.. 148	Potatoes	bbls.. 47
Hides and skins	packages.. 482	Pecans	do.... 10
Wool	bags.. 428	Cattle and hogs	head.. 118
Sugar	hhds.. 58	Horses and mules	do.... 11
Hay	bales.. 474	Stone	tons.. 4,600
Seed cotton	sacks.. 152		

Return freights of general merchandise and plantation supplies.

The estimated value of the commerce was given at $5,370,000.

Above Shreveport to Fulton, Ark., the river was navigable about nine months, and during the remainder of the year boats ran to Gilmer, La., 46 miles above Shreveport. Nine steam-boats of from 75 to 300 tons, drawing from 15 to 30 inches light

and 3 to 6 feet loaded, made 124 round trips. The following down freights were reported:

Cotton	bales..	9,000
Cotton seed	tons..	3,000
Cotton-seed meal	do....	100

Return freights of general merchandise and plantation supplies, estimated at 7,000 tons.

The following information has been furnished by the Board of Trade of Jefferson, Tex., regarding the route through Cypress Bayou and the lakes to Shreveport, La. This water-way was in navigable condition ten months of the fiscal year, but on account of a combination between the railroad and steam-boat interests navigation was not commenced until February 12. Since that date five small steamers (tonnage and draught not given) have been employed. Only a small quantity of cotton, etc., was shipped, the traffic consisting principally of merchandise from New Orleans, which was transferred to the smaller boats at Shreveport. Three thousand barrels sugar, 800 barrels molasses, 1,200 sacks coffee, 300 barrels rice, and 13,000 packges miscellaneous freight were carried to Jefferson. Large quantities of timber were rafted to the mills at Jefferson and Shreveport. Bills of lading of two shipments of molasses from New Orleans to Jefferson were forwarded by the Board of Trade. One dated April 19, 1889, shipped by river, gave the through rate at 25 cents per 100 pounds. The other shipment, by railroad, dated June 12, 1889, gave the rate at 91 cents per 100 pounds.

W 2.

IMPROVEMENT OF CYPRESS BAYOU, TEXAS AND LOUISIANA.

The improvement of Cypress Bayou includes the entire navigable route from Shreveport, La., to Jefferson, Tex., via Twelve-Mile Bayou, Sodo, and Fairy lakes, and Cypress Bayou. An examination was made by the United States in 1872, and the improvement begun the same year and completed in 1880, a well-defined channel, marked with sign-boards, from Shreveport to Jefferson, a distance of 65 miles, being the result.

In July, 1884, a steamer was employed in removing obstructions. The route was re-examined in December, 1884, and recommendation made that it be improved further by removing stumps, etc., from the channel through Twelve-Mile Bayou and Sodo Lake, so as to make the entire depth of water available for navigation, straightening the channel through Fairy Lake and removing stumps to a depth corresponding to that obtained in Sodo Lake, and reopening cuts in Cypress Bayou by dredging. Also to indicate the cleared channel through the lakes by sign-boards. Such improvement, it was thought, would give good and safe navigation to Jefferson for seven to eight months in the year, and relieve the people from exorbitant rates charged on freight by rail.

The United States dredge *Lone Star*, rebuilt for this work, was employed during the fiscal year 1888 in Cypress Bayou proper, opening a good navigable channel from Jefferson to Fairy Lake, and I am informed by the steamboat men that this work resulted in an immediate reduction of about 60 per cent. on competing railroad rates, and nearly one-half on insurance.

The river and harbor act of August 11, 1888, provided "$5,000, or so much thereof as may be necessary," for continuing this work from the item of appropriation for "improving Red River, Louisiana and Arkansas," and report of operations during the past year with estimates

will be found under that head. The small balance available July 1, 1888, was expended in connection with this allotment.

The following appropriations have been made for this improvement:

By acts of—	
June 10, 1872	$10,000
March 3, 1873	50,000
August 14, 1876	13,000
June 18, 1878	15,000
March 3, 1879	6,000
August 5, 1886	18,000
Amount appropriated to June 30, 1888	112,000

Money statement.

July 1, 1888, amount available	$338.29
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	338.29

W 3.

IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

Nothing has been done for the improvement of these streams during the fiscal year. All work in this district was delayed during the fall of 1888 by yellow-fever at Jackson, Miss. (44 miles east of Vicksburg), the quarantine regulations throughout the South rendering it impracticable to obtain men or to deliver supplies. Under authority of the Secretary of War the office was transferred to St. Louis, Mo., temporarily, and the commencement of operations in streams in this vicinity was delayed until cold weather. For the greater portion of the time since, the stages of Ouachita River have not been favorable to beginning and continuing snag-boat work.

Under provision contained in the act of August 11, 1888, authorizing $4,500 "to be expended for the construction or purchase of a crane boat with steam power," I bought in September at Shreveport, La., a small steam-boat (the *Col. Hooker*), of 88 tons and about 20 inches draught, for $1,800. This boat is 112 feet long, 26 feet beam, with 3 feet depth of hold, and is supplied with two non-condensing engines of 10½ inches diameter of cylinder and 3 feet stroke of piston, and two iron boilers, 22 feet long by 3½ feet diameter, which were inspected by the United States inspectors a few days before the purchase and found in good condition. She was repaired and strengthened, shears fitted up, and a new 15-horse-power hoisting engine purchased for her at an additional cost of $1,632.21, making the total cost of the boat and machinery $3,432.21. The sum of $732.82 also has been expended for outfit for this boat and the *Wagner*.

It is proposed to expend the available balance this summer and fall in removing wrecks, snags, logs, leaning timber, etc., in accordance with the plan heretofore pursued, using for this purpose the snag-boats *Wagner* and *Hooker*, belonging to this work, and for the heavier ob-

structions one of the larger snag-boats, either the *Howell* or the *Meigs*, if it can be spared from the work to which it belongs.

The former appropriations were:

By acts of—	
March 3, 1871	$51,000
June 10, 1872	100,000
March 3, 1873	60,000
August 14, 1876	12,000
June 18, 1878	10,000
March 3, 1879	10,000
June 14, 1880	8,000
March 3, 1881	12,000
August 2, 1882	12,000
July 5, 1884	15,000
August 5, 1886	17,500
August 11, 1888	20,000
Amount appropriated to June 30, 1889	327,500

The amount expended on present project to June 30, 1889, including cost of iron hull snag-boat and outfit was $198,077.16.

The present project contemplates removal of wrecks, logs, snags, leaning timber, etc., and improvement of shoal places from Camden, Ark., to mouth of Black River, a distance of 369 miles. No estimate of cost of such improvement can be submitted, as obstructions are forming continually and require removal from time to time.

The amount estimated for can be expended profitably during the fiscal year ending June 30, 1891, in removing obstructions, etc., in accordance with the above project. I recommend also the systematic clearing of the banks of leaning timber to prevent slides and caving, and to open the river. This work is especially necessary in the bends and in the narrower portions of the river for the immediate benefit of navigation, but ought to be continued throughout the whole stream to prevent the formation of snags and jams.

Dredging should also be tried at the most obstinate shoals, and the construction of temporary and inexpensive wing-dams, built mostly of material cut in clearing the banks.

Money statement.

Amount appropriated by act of August 11, 1888	$20,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	4,165.03
July 1, 1889, balance available	15,834.87
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	40,000.00

COMMERCIAL STATISTICS.

In the past fiscal year Harrisonburg, 95 miles above the mouth of Black River, was the head of low-water navigation for about eight weeks, as all boats had to turn back on account of a shoal at that place. For seven weeks longer they could run only to Fenner's Bar, 20 miles below Monroe, but during the remainder of the time navigation was good to Monroe and Camden. Twelve steam-boats, of from 100 to 960 tons, and drawing from 1½ to 4 feet light and 5 to 8 feet loaded, plied between

Camden and New Orleans, making 75 round trips. The following down freights were reported:

Cotton	71,152	Staves	491,400
Cotton-seed	53,214	Wood	520
Cotton-seed meal	6,143	Soap stock	30
Hides and skins	112	Bones	51
Wool	246	Pecans	9
Cattle	30	Apples	223
Hogs	1,294	Potatoes	127
Sugar (barrels)	28	Peas	192
Sugar (hogsheads)	17	Poultry	7
Molasses	5	Eggs	4
Moss	35	Rags	18
Rice	795	Lumber and timber	2,650,000
Seed cotton	14		

Return freights of general merchandise and plantation supplies.

In addition to the above, several large boats made trips during the year from St. Louis to the Ouachita River, and nine steamers and five tug-boats were engaged in the tributary trades, connecting with the larger boats and running to Trinity and Monroe. The secretary of the cotton exchange at Monroe states that about 6,000 bales of cotton were delivered at that place.

The estimated value of the commerce for the year was reported to be not less than $8,798,000.

W 4.

IMPROVEMENT OF OUACHITA RIVER, ARKANSAS, ABOVE CAMDEN.

This is a new work. An examination of this part of Ouachita River was made in 1887, to comply with requirement of river and harbor act of August 5, 1886, and the plan recommended for its improvement consisted in cutting the leaning timber, girdling trees, removing snags and logs, and building brush-dams at the shoals, to improve the river from Camden up to Arkadelphia, Ark. (76 miles), so as to render this portion navigable at a stage that affords navigation to former place. Estimated cost, $9,000.

The river and harbor act of August 11, 1888, appropriated $9,000 to complete the work.

Operations have not been commenced. The work can be performed to advantage during low stages only, and as the low-water season was so far advanced when the funds became available it was deemed advisable to postpone operations until this summer, as the project was based on estimates for four months' continuous work, and a suspension, care of plant during the mean time, and a reorganization of force would necessarily increase the cost.

The appropriation will be expended in carrying out the project during the low-water season this summer and fall.

Money statement.

Amount appropriated by act of August 11, 1888	$9,000
July 1, 1889, balance available	9,000

COMMERCIAL STATISTICS.

Owing to the obstructed condition of the river there was little navigation during the past year. Two steam-boats of 100 tons each, and drawing from 21 inches light

to 3 feet loaded, made three trips above Camden for a distance of about 50 miles. The following down freights were reported:

Cotton	bales..	250
Staves	number..	25,000
Logs (rafted timber)	do....	5,000

Return freights of general merchandise and plantation supplies.

I am informed that the present rate on cotton by rail from Arkadelphia to New Orleans is $3.85 a bale, but that one of the lower-river packet companies has arranged to run to Arkadelphia during the cotton season and offer a rate of $2 per bale, and a corresponding decrease on other freights.

W 5.

IMPROVEMENT OF BAYOU D'ARBONNE, LOUISIANA.

Bayou D'Arbonne is formed by the junction of the South, Middle, and North or Corney branches, near Farmerville, in northern Louisiana, flows in a southeasterly direction, and enters Ouachita River about 6 miles above Monroe.

An examination and survey were made in 1883, and the plan of improvement is based upon the latter. The bayou is navigable during high stages only, and the project contemplates the removal of snags, logs, wrecks, leaning trees, etc., obstructing navigation between Stein's Bluff on Bayou Corney and the mouth, a distance of 42½ miles, at an estimated cost of $15,000.

Work was begun in 1884 and continued in 1886 and 1887, resulting in the removal of a large number of obstructions from the D'Arbonne for 29 miles above its mouth, putting that stretch in good navigable condition and resulting in a reduction of freight rates of about 20 per cent. The work is not permanent, however, as new obstructions are added from time to time, which require removal in the interest of safe navigation.

When operations in Little River were suspended the snag-boat *Hooker* and chopping party were transferred to this work. After making some minor repairs of the snag-boat at Monroe, La., they entered the mouth of D'Arbonne June 18, and proceeded up-stream to Farmerville Landing, on Bayou Corney, where operations were commenced. The water was 12 feet on the Farmerville gauge, but began falling so rapidly that on the 25th the snag-boat had to return to deeper water near the mouth, where it was employed the remainder of the month. The chopping party began operations at Stein's Bluff, and worked steadily down-stream, thoroughly removing the channel obstructions which the low stage of water brought to view, and clearing the bends and abrupt points of leaning timber and brush. The work is of such recent date that no estimate of the advantages derived therefrom can be made, but steam-boat men state that the removal of obstructions has enabled them to make trips at a lower stage than before.

The following is a summary of the work done during June, 1889:

	Number.
Logs and snags removed from channel	1,152
Stumps removed from channel	33
Side-jams removed	2
Shore snags and stumps cut	191
Leaning trees removed	1,296
Leaning trees girdled	2,226
Leaning trees topped	18
Square yards willows and brush cleared from banks	3,746

Operations will be continued so far as practicable with the balance available, but it is probable that it will be expended before August 1.

If the entire amount estimated for completing existing project is made available in the next appropriation, the work can be done with such thoroughness as not to require attention for some years to come. The former appropriations were:

By acts of—	
July 5, 1884	$5,000
August 5, 1886	2,000
August 11, 1888	2,000
Amount appropriated to June 30, 1889	9,000
Amount expended to June 30, 1889	8,000

Money statement.

Amount appropriated by act of August 11, 1888	$2,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	1,000.00
July 1, 1889, balance available	1,000.00
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	6,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

During the fiscal year 1888–'89 this bayou was navigable for eight months, November to June, inclusive; boats running to Stein's Bluff during that period. Four steam-boats ranging from 20 to 120 tons, and drawing from 10 to 24 inches light, and 20 inches to 4 feet loaded, made forty-seven round trips. The following down freights were reported:

Cotton	bales	10,000
Hides	pounds	10,000

Return freights of general merchandise and plantation supplies, aggregating in value about $250,000.

The estimated value of the commerce of the stream was reported to be about $754,000.

W 6.

IMPROVEMENT OF LITTLE RIVER, LOUISIANA.

This is a new work. The stream is formed by Dugdemona River and Bayou Castor at the junction of Winn, Grant, and Catahoula parishes, Louisiana, flows in a southeasterly direction and enters Catahoula Lake. The outlet from Catahoula Lake on the northeast is also called Little River. It flows in a northeasterly direction, uniting with Ouachita and Tensas at Trinity, La., in forming Black River.

An examination was made by the United States in 1887, and the project for improvement based thereon contemplated removing sunken logs and cutting the most obstructive leaning timber in the stretch of river from the lake to Trinity, a distance of about 25 miles, at an estimated cost of $2,500. The upper stream was not considered worthy of improvement.

The river and harbor act of August 11, 1888, appropriated $2,500 for carrying out this project.

After suspending operations in Bayou Bœuf, the snag-boat *Hooker* and chopping party under superintendence of Walter S. Davis were transferred to this stream and began work May 23, and continued until June 13, when the water had risen to so high a stage that it was necessary to suspend operations. The following obstructions were removed:

	Number.
Logs and snags from channel	2,569
Stumps from channel	77
Side jams	7
Shore snags cut	1,354
Stumps cut from banks	13
Leaning trees	1,568
Leaning trees topped	60
Leaning trees girdled	1,528

This work put the river between Catahoula Lake and Black River in safe condition for navigation at ordinary stages. The available balance will be applied to the further removal of sunken logs, stumps, etc., in this stretch during the period of extreme low water. No further appropriation is recommended. Any additional work required after expenditure of funds now available, such as cutting a leaning tree now and then, or removing an occasional log from the channel, should be done by the people directly benefited by the work.

Money statement.

Amount appropriated by act of August 11, 1888		$2,500.00
July 1, 1889, amount expended during fiscal year	$1,701.60	
July 1, 1889, outstanding liabilities	6.67	
		1,708.27
July 1, 1889, balance available		791.73

COMMERCIAL STATISTICS.

During the fiscal year 1888–'89 two steam-boats of 40 and 50 tons, drawing 14 and 24 inches light and 3 and 4 feet loaded, made 64 trips in this stream; three tow-boats, drawing 2½, 4, and 9 feet, with barges, made 13 trips; and three large steam-boats of 250, 350, and 445 tons, drawing from 2 to 3 feet light and 5 to 6 feet loaded, made 6 trips. The river was navigable for six months, January to June inclusive, and the following down freights were reported:

Cotton	bales	5,200	Staves	number	100,000
Cotton-seed	tons	2,500	Wood	cords	500
Hides	pounds	3,000	Lumber (sawed)	feet, B. M.	300,000
Hogs	head	150	Logs (rafted timber)	number	100,000

Return freights of general merchandise and plantation supplies to the value of about $96,000.

The estimated value of the commerce of the stream for the year is given at $350,000.

W 7.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

Nothing has been done for the improvement of this stream during the fiscal year. The work should be done during the low-water season, and, for the reasons stated in my report on Ouachita and Black rivers, it was impracticable to begin operations in the fall of 1888.

The project contemplates cutting overhanging timber and removing snags, logs, wrecks, etc., obstructing navigation from Baxter to the

mouth, a distance estimated to be 213 miles. New obstructions are forming continually, which require removal from time to time, hence no estimate for permanent improvement is given. With the available balance it is proposed to continue the removal of obstructions in accordance with the plan heretofore pursued, during this summer and fall, and the present intention is to use for this purpose the light snag-boat *Hooker* and chopping party now employed in Bayou D'Arbonne, which have performed effective and economical work in other tributaries of Ouachita River.

The following appropriations have been made for this work:

By act of—	
March 3, 1881	$8,000
August 2, 1882	5,000
July 5, 1884	5,000
August 5, 1886	5,000
August 11, 1888	5,000
Amount appropriated to June 30, 1889	28,000

Before this improvement was commenced three months was the average duration of the navigable season. Now it lasts six months, and boats make trips in about one-third less time, reducing the freight rates about 33⅓ per cent. from what they were before. I am informed by Capt. E. B. Cryer, superintendent of the Cryer Line steam-boats running in this trade, who has been engaged in navigating this and other tributaries of Ouachita River for the last twenty-six years, that if the logs, stumps, etc., on the bottom were removed, insurance rates would be reduced and light-draught boats enabled to run to Lind Grove, La., nearly 100 miles above the mouth, the entire year, at a great saving to the merchants and planters who now have to haul their products and supplies from 50 to 75 miles by wagon when the boats stop running.

The amount asked for the fiscal year ending June 30, 1891, can be profitably expended in continuing the removal of obstructions.

Money statement.

Amount appropriated by act of August 11, 1888	$5,000.00
July 1, 1889, balance available	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000.00

COMMERCIAL STATISTICS.

The principal business of Bayou Bartholomew is done by small steam-boats connecting with the Ouachita River boats and the railroad at Monroe. No information of the amounts of freight carried by these boats has been obtained, although the masters have been asked for it. One through boat from New Orleans of 233 tons made two trips into the bayou and brought out 2,118 bales of cotton and 431 tons of seed. As the bayou at present is the only means of transporting the products of the bordering country, it is thought that the business was approximately the same as reported last year.

W 8.

IMPROVEMENT OF BAYOU BŒUF, LOUISIANA.

Bayou Bœuf rises in southeastern Arkansas, flows in a southerly direction, and enters Ouachita River at Stafford's Point, about 10 miles above Harrisonburgh, La.

The plan of improvement is based upon an examination made by the United States in 1880. The project contemplates the removal of snags, logs, and leaning timber obstructing navigation between Wallace's Landing and the mouth, about 280 miles. Owing to small appropriations the work has extended over a period of eight years, and the cost increased accordingly. New obstructions are forming continually, and require removal from time to time, hence no estimate for permanent improvement is given. An examination of three outlets of the bayou near Point Jefferson, La., was made in 1884, and their closure recommended at an estimated cost of $8,500.

The work done heretofore was carried on in 1881, 1882, and 1884. The removal of obstructions benefited navigation greatly and lessened the dangers thereof, and boats were enabled to run to Point Jefferson during high water. Outlet No. 1 was closed in 1887.

The work of closing Outlets 2 and 3 was resumed by A. Hefner in September, 1888, and completed early in October. The dam closing Outlet No. 2 contained 10,820 cubic yards and that at Outlet No. 3 940 cubic yards of earth embankment. The total cost of the closure of the three outlets to the United States has been $5,441.78. This work was conducted under the superintendence of Overseer Walter S. Davis, and on its completion he made an examination of Bœuf River below, preliminary to resuming work of removing obstructions.

After constructing a flat-boat for quarters for employés, etc., a chopping party was organized November 8 and began operations at the mouth of Bayou Bonne Idee (Point Jefferson), continuing down to Liddell's Landing, about 4 miles below the Vicksburg, Shreveport and Pacific Railroad Bridge, which was reached the last of December. The water at that time having reached a stage too high for advantageous work, operations were suspended and the party transferred to Bayou Macon. After expending the funds available for improving Tensas River and Bayou Macon the chopping party, joined by the United States snag-boat *Hooker*, returned to this stream April 25. The water having fallen sufficiently, operations were resumed at the point where suspended in December and carried down-stream to the mouth, which was reached May 22.

The following obstructions have been removed during the fiscal year:

Snags and logs from channel	2,648
Stumps	367
Jams	16
Side jams	23
Shore snags	3,668
Leaning trees	2,130
Leaning trees girdled	1,557
Leaning trees topped	102
Brush cleared from banks, sq. yds.	3,770

The work extended from Point Jefferson, (19 miles below Wallace's) to the mouth of the bayou, and has resulted in putting it in fair navigable condition for the present. That portion of the stream above the Vicksburg, Shreveport and Pacific Railroad Bridge was badly obstructed

by snags, stumps, and sunken logs, no work having been done in it since 1881. Below the bridge the bayou was less obstructed, having been worked over in later years; still a considerable amount of work was done and more is yet required. The light snag-boat *Hooker*, Jo. M. Muir, master, rendered effective service in the latter stretch, in removing tree-slides and logs and snags from the channel; and those too heavy or too firmly imbedded in the mud to be removed by the boat were destroyed with high explosives.

The closure of the three outlets near Point Jefferson has prevented the water of Bayou Bœuf from running into Lake Lafourche and being dissipated in the swamps beyond, and eventually leaving the original channel entirely and ruining navigation therein. By confining the flow to its natural direction the season of navigation has been prolonged and a channel scoured through the sand-bar opposite Outlet No. 1, which is rapidly increasing in depth and the obstruction will soon disappear.

The balance available will be applied to resuming the removal of obstructions in the same manner pursued during the past year, as soon as the snag-boat *Hooker* can be spared for this work.

With the appropriation asked for the fiscal year ending June 30, 1891, it is proposed to continue the work by systematically clearing the banks for some distance back from the bayou, building brush wing-dams to scour the bars, and removing shore-slides and logs and snags from the channel. The snag-boat *Hooker* and a chopping party of fifteen to twenty men can be employed to advantage for at least six months at a cost approximating $1,650 per month.

The former appropriations were:

By acts of—	
March 3, 1881	$5,000.00
August 2, 1882	5,000.00
July 5, 1884	5,000.00
August 5, 1886	5,000.00
August 11, 1888	6,000.00
Amount appropriated to June 30, 1889	26,000.00
Amount expended to June 30, 1889	25,022.48

Money statement.

July 1, 1888, amount available	$197.25
Amount appropriated by act of August 11, 1888	6,000.00
	6,197.25
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	5,219.73
July 1, 1889, amount available	977.52
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

COMMERCIAL STATISTICS.

One steamer of 150 tons, drawing 30 inches light and 5 feet loaded, made eight trips in this bayou during the fiscal year, bringing out the following freights:

Cotton ..... bales..	4,334	Cattle ..... head..	4
Cotton-seed ..... tons..	16,679	Staves ..... number..	3,035
Hides ..... package..	1	Wood ..... cords..	51
Wool ..... bags..	5	Poultry ..... coops..	12

Return freights of general merchandise and plantation supplies.

The value of the business of the year was estimated at not less than $475,000.

W 9.

IMPROVEMENT OF TENSAS RIVER AND BAYOU MACON, LOUISIANA.

Tensas River has its source in northeastern Louisiana, in Lake Providence, flows in a southerly direction, and unites with Ouachita and Little rivers at Trinity, La., in forming Black River. By the act of 1884 Bayou Macon was united under the same head of appropriation with Tensas River. This bayou rises in Desha County, southeastern Arkansas, flows in a southerly direction, entering Tensas River about 40 miles above its mouth.

Examinations of these streams were made in 1880, upon which the plan of improvement is based. The project contemplates removing snags, logs, and leaning timber obstructing navigation in the Tensas between Dallas and its mouth (about 180 miles), at an estimated cost of $23,000, and the removal of the same class of obstructions in Bayou Macon from Floyd, the present head of navigation, to its mouth (about 130 miles), at an estimated cost of $17,000.

Work in Tensas River was begun in 1881 and continued in 1884, benefiting navigation by the removal of obstructions from the lower 80 miles of the stream. Work in Bayou Macon was carried on in 1886–'87, resulting in the removal of the principal obstructions between Floyd and the mouth. This work was not permanent, however, as new obstructions have been added from time to time.

During the past fiscal year operations have been as follows: The snag-boat *Hooker* and the chopping party, under the superintendence of Walter S. Davis, were transferred to these streams in January. Work was commenced in Bayou Macon February 1 and continued until April 14. On April 15 work was commenced in Tensas River, and continued until April 22 when, the funds being practically exhausted, the boat and party were withdrawn, and returned to the improvement of Bayou Bœuf, Louisiana. Operations in Bayou Macon extended over the entire portion included in the project; those in Tensas were confined to the stretch of river between Mound Bayou and Tensas Bluff, about 25 miles, that portion having been reported by steam-boat men as badly obstructed. The light snag-boat *Hooker* rendered effective service in taking obstructions from the channel, dynamite being used freely and effectively in removing those too heavy for her appliances. The work has been well done, and the steam-boat men appear great y pleased with its results. Capt. L. V. Cooley, master of the steamer *H. Hanna Blanks*, stated that it has so materially benefited navigation that "the run from mouth of Bayou Macon to Floyd and return has been shorted 12 hours," and that "the stretch above the Vicksburg, Shreveport and Pacific Railroad Bridge, always crooked and bad, received special attention, and is now a comparatively good piece to run."

The amounts expended during the year were $4,343.99 in Bayou Macon and $425 in Tensas River.

The following is a list of the obstructions removed:

	Number.
Logs and snags from channel	1,531
Stumps from channel	408
Side jams	31
Shore snags and stumps	1,483
Leaning trees	2,123
Leaning trees topped	743
Leaning trees girdled	1,225

The former appropriations were:

By acts of—	
March 3, 1881	$3,000.00
July 5, 1884	4,000.00
August 5, 1886	4,000.00
August 11, 1888	5,000.00
Amount appropriated to June 30, 1889	16,000.00
Amount expended to June 30, 1889	15,768.99

(Tensas River, $7,425; Bayou Macon, $8,343.99.)

With the small balance available nothing further can be done unless a party should be working in vicinity of these streams, in which case it will be expended in removing obstructions.

With the amount asked for the fiscal year ending June 30, 1891, it is proposed to continue the work of cutting leaning timber and removing logs and snags and to build brush dams where required.

Money statement.

Amount appropriated by act of August 11, 1888	$5,000.00
July 1, 1889, amount expended during fiscal year	4,768.99
July 1, 1889, balance available	231.01
Amount (estimated) required for completion of existing project	24,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Tensas River was navigable for small boats all the year, and Bayou Macon to Floyd about five months. Eight steam-boats, of from 40 to 350 tons, and drawing 12 to 30 inches light and 2 to 6 feet loaded, made about 93 trips in these streams. The following down freights were reported:

Cotton	bales.. 11,000	Hay	bales.. 500
Cotton-seed	tons.. 4,000	Moss	do.... 100
Hides	pounds.. 10,000	Staves	number.. 200,000
Wool	do.... 5,000	Wood	cords.. 1,000
Cattle	head.. 500	Logs (rafted timber)	number.. 5,000
Hogs	do... 1,000		

Return freights of general merchandise and plantation supplies; estimated value, $550,000.

The estimated value of the commerce of the stream for the year is given at about $1,250,000.

W 10.

IMPROVEMENT OF BAYOUS RONDEWAY AND VIDAL, LOUISIANA.

This is a new work. To comply with the requirements of the river and harbor act of August 5, 1886, an examination of these streams was made in 1887. (Report of Chief of Engineers, 1887, page 1497.) The improvement proposed was the removal of obstructions, chiefly leaning trees, from the canal and that part of Bayou Vidal which would remain open from Lake Palmyra to the line of levee to be built by State authority north of the lake, etc., at an estimated cost of $1,000.

The river and harbor act of August 11, 1888, appropriated $1,000 for this purpose.

A chopping party, under overseer W. W. Moore, commenced work September 17, where the new levee crosses Bayou Vidal and continued down-stream to Lake Palmyra, which was reached October 13, and operations suspended after having accomplished the following work:

	Number.
Snags removed	7
Stumps cut	155
Shore snags	29
Leaning trees cut	585
Leaning trees topped	7
Leaning trees girdled	122
Brush cut from banks ..... sq. yds..	149

This completed the project so far as clearing obstructions, but on account of the levee across the bayou the current was too sluggish to float off the trees cut, etc., and prevent their forming new obstructions. These were all chopped into short lengths of 10 to 12 feet, so as to be easily handled when the water reached a stage high enough to get them out of the bayou. In March the water having risen sufficiently a small steam-boat and crew were employed during the latter part of the month in collecting débris left by the chopping party and towing it out into the current. Operations of the year have rendered navigation safe for small boats and reduced insurance to the same rates charged on the Mississippi River.

All work entertained in the project for these streams is completed, but a further appropriation of $2,000 is recommended for the following reason:

The new levee cuts off Bayous Vidal and Rondeway from Lake Palmyra, the old bend of the Mississippi River at the part where they united to form Bayou Vidal proper. Before the old levee system along the west shore of the bend broke down, Bayou Vidal was connected with the lake by a cut or "canal" for the purpose of draining the swamp above. The canal has been used of later years for the navigable route from Lake Palmyra into the bayou, and the old line of the bayou has become obstructed by fallen timber and stumps. Property owners at the junction of Vidal and Rondeway claim the "canal" and issued notice that a tax would be levied on all freights passing through it. I propose, therefore, to reopen the old bayou and so save the steam-boat interest from such an imposition. This work will require about 10,000 cubic yards of dredging and an expenditure of about $500 for explosives, chopping, etc. The best dredge for the purpose is the *Lone Star* now in Red River. The estimates are as follows:

Towing dredge from Red River to Bayou Vidal and return	$600
One month's work, dredge and crew	900
Pay of chopping party and explosives	500
Total	2,000

Money statement.

Amount appropriated by act of August 11, 1888	$1,000.00
July 1, 1889, amount expended during fiscal year	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	2,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Lake Palmyra has been navigable for small boats to New Carthage, at mouth of Bayou Vidal, during the entire fiscal year 1888–'89, except the month of October, when they could not enter the mouth of the lake. Bayou Vidal was navigable for three months, February, March, and April. The *Sargent*, a steamer of 90 tons, drawing 2 feet light and 4 feet loaded, made 94 trips in this trade, and the *Jimmie B.*, of 60 tons, drawing 12 inches light and 2 feet loaded, 50 trips.

The freights reported were as follows:

Down freights.

Cotton	bales..	7,000
Cotton-seed	tons..	6,000
Wool	pounds..	1,000
Moss	bales..	200
Wood	cords..	400

Return freights.

Pork and bacon	pounds..	400,000
Grain	sacks..	5,000
Hay	tons..	500
Sugar and molasses	barrels..	600
Flour and meal	do....	1,800
Cotton-seed and meal	tons..	400
Sawed lumber	feet, B. M..	500,000

The estimated value of the commerce at the present time in round numbers is given at $750,000.

W 11.

IMPROVEMENT OF BIG BLACK RIVER, MISSISSIPPI.

No work has been done in this stream since 1884. The appropriation in the river and harbor act of August 5, 1886, contained the following proviso: "No part of this appropriation shall be used until the State of Mississippi shall have first caused the bridges over said stream south of the Vicksburg and Meridian Railroad to be so constructed as not to obstruct the navigation of said stream." This requirement has not been complied with yet, and the condition of affairs is practically the same as set forth in my last report.

To conform to the act of August 5, 1886, the State of Mississippi passed an act March 7, 1888, requiring the Louisville, New Orleans and Texas Railway Company to remove the obstruction to navigation caused by the fixed span of its bridge crossing this about 15 miles above the mouth, etc. (See Report of Chief of Engineers, 1888, page 1357.)

No mention was made of the county bridge at Baldwin's Ferry, and as the supervisors are unwilling either to alter this bridge, or to repair it, it serves both as an obstruction to the free navigation of the stream and to the expenditure of the appropriation. The State legislature of Mississippi will meet January 7, 1890, when the matter will probably be brought up again for action.

As stated in my last report, the railway company signified its intention of complying with the requirements of this act, and in August, 1888, submitted plan of proposed changes and alterations of the bridge, which was referred to the Secretary of War and approved by him September 8, 1888. The work is now in progress, and the general manager of the railway company reports that he expects to complete it about the 1st of November next.

The former appropriations were:

By act approved July 5, 1884	$5,000
By act approved August 5, 1886	5,000

No further appropriation is recommended.

Money statement.

July 1, 1888, amount available	$5,000.00
July 1, 1889, balance available	5,000.00
Amount (estimated) required for completion of existing project	22,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

During the fiscal year 1888–'89 four barge-loads of staves, a total of 143,000 pieces, were brought out of this stream.

A small steamer of about 60 tons, drawing 14 inches light and 3 feet loaded, made eight trips into the lower part of the river, but no information of freights carried could be obtained.

W 12.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

Yazoo River, about 264 miles in length, is formed by the junction of Yalabusha and Tallahatchee rivers, flows in a general southwesterly direction, through one of the richest sections of country in the South, and enters Mississippi River 5 miles above Vicksburg.

An examination of wrecks of gun-boats, steamers, and other obstructions placed in the river during the war was made by the United States in 1873, and a similar examination, which included the natural obstructions to navigation, was made in 1874. The project contemplates the removal of wrecks, logs, snags, overhanging timber, etc., obstructing navigation throughout the entire length of the river. The work can not be permanent, as new obstructions, caused by floods, sliding banks, etc., are brought into the river each year; consequently no detailed estimates have been submitted.

The wrecks of eleven steamers, sunk during the war, were removed by contract during 1873–'74. In 1875 and 1877 the United States snag-boat *O. G. Wagner* was employed in removing wrecks and other obstructions. The snag-boat *John R. Meigs* was completed in 1879, and the principal work since has been carried on with that boat. The results of the work are marked; the large number of wrecks and many natural obstructions which limited the navigable season have been removed, and the river is navigable the entire year.

The snag-boat *Meigs* left Vicksburg, Miss., September 1, 1888, for St. Louis, Mo., to undergo extensive repairs authorized by river and harbor act of August 11, 1888, arriving at the latter place September 13. Repairs were commenced October 1, and completed by the middle of December. They consisted of a new $\frac{5}{16}$-inch steel bottom, 13 new knuckle plates, 6 new plates on sides, 4 new plates on bow, and taking up iron forward deck, straightening the beams, and relaying deck and

reinforcing it with 5 new plates; altering and repairing cabin; recovering roof and boiler-deck; building a new wheel; repainting the boat; minor repairs of wood-work, etc., at a cost of $10,000. An additional amount of $838.08 was expended for four new iron capstans to replace wooden ones, repairs of capstan machinery, etc.

After receiving supplies, the boat left St. Louis December 18, and arrived at Vicksburg December 30. I made a trip of inspection of the river to its head, including Tchula Lake January 4–11, and finding it badly obstructed in several places by tree-slides ordered the boat to return and begin work at once. Work was continued in Yazoo till February 1, when the boat was transferred to Tchula Lake. By the time operations in the latter stream were suspended, the Yazoo had reached a stage too high for advantageous work, and the *Meigs* was transferred to Red River temporarily. Returning in May the boat resumed work in this and Tallahatchee River, having been employed in Yazoo May 5–17 and June 4–12.

The following is a summary of the work performed in Yazoo River during the past year:

Snags and logs pulled	454
Stumps pulled	39
Side jams removed	1
Stumps and shore-snags cut	181
Leaning trees cut	1,364
Leaning trees girdled	131
Wing-dams built	1

At present the river is at too high a stage for effective work, and operations will not be resumed until low water.

In the last fifty-two years fifty-five steam-boats have been lost and destroyed in this river, about twenty of which were wrecked during the war. One above mouth of Big Sunflower River, one at French Bend, and one about 9 miles below Honey Island (the *Barksdale*, burned in 1888) are reported badly in the way, and four others as more or less in the channel. After every rise and fall new snags appear, and where the banks are heavily timbered trees slide into the river, singly and by dozens, and having so much sediment sticking to their roots, form dangerous snags, difficult to remove. If appropriations were made so as to allow about four months' work each year this river could be kept in good navigable condition.

The act of August 11, 1888, provided $8,000 of the amount appropriated for Yazoo River "for constructing a pumping dredge-boat." I have found and tried a pumping-dredge at Alton, Ill., consisting of a hull about 28 by 64 feet, deck-house, boiler and fittings, feed-pump, driving-engine, Van Wie centrifugal pump, 12-inch suction and 10-inch discharge, No. 6 pressure-pump, with hose and jet, small two-cylinder hand deck-pump, small single cylinder, single drum-hoisting engine, and suction and discharge pipe, belting, etc.; all new. The hull was built and fitted up last fall, and is in good order. The price is $2,500 at Alton, which, according to my estimate, is about half its original cost. A larger pressure-pump will be needed, and probably a double drum-hoisting engine. Judging from the trial, I am confident that this dredge can be made a success in *mud* (no doubt about sand and gravel) within the amount allotted, either by the use of additional jets or cutters or other devices that may suggest themselves while using it, and I therefore have recommended the purchase.

It is probable that the balance available for snagging, etc., will be expended by or before the end of October, 1889.

The following are the estimates for the fiscal year ending June 30, 1891:

A small light-draught boat for use in the upper river and the tributaries to Yazoo, and for towing and general service in this district	$10,000.00
Expenses of same	8,000.00
Expenses of snag-boat *Meigs*	10,000.00
Expenses of dredge	6,000.00
Flat-boat and outfit, and expenses of chopping parties engaged in systematic clearing of the river banks	10,000.00
General repairs to plant and outfit, office expenses and contingencies	6,000.00
Total	50,000.00

This amount can be profitably expended in one season.

The former appropriations were:

By acts of—	
March 3, 1873, applied to the removal of eleven wrecks sunk during the war	$40,000.00
March 3, 1875	12,000.00
August 14, 1876	15,000.00
June 18, 1878	25,000.00
March 3, 1879	15,000.00
June 14, 1880	12,000.00
March 3, 1881	6,000.00
August 2, 1882	8,000.00
July 5, 1884	10,000.00
August 5, 1886	15,000.00
August 11, 1888	32,000.00
Amount appropriated to June 30, 1889	190,000.00
Amount expended to June 30, 1889	177,557.74

Money statement.

July 1, 1888, amount available	$993.44
Amount appropriated by act of August 11, 1888	32,000.00
	32,993.44
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	20,551.18
July 1, 1889, balance available	12,442.26
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	50,000.00

COMMERCIAL STATISTICS.

The river was navigable the entire year. Full statistics could not be obtained.

The Yazoo and Tallahatchee Transportation Company's steamers, 5 in number, ranging from 110 to 233 tons and drawing from 15 to 22 inches light, and 4 to 5½ feet loaded made 185 round trips, carrying general merchandise and plantation supplies of which no record was kept, and bringing out 30,554 bales of cotton, about 25,000 tons of cotton seed, 31,000 staves, and miscellaneous freights.

The Pugh Line steamers of Yazoo City and a steamer belonging to the Yazoo City Oil Mill run in this trade, and independent steamers make occasional trips. No definite information of the amount of business done by these boats could be obtained, although the owners have been asked for it repeatedly. It is estimated, however, that they carried not less than 10,000 bales of cotton and 5,000 tons of seed, besides miscellaneous freights.

The amount of cotton received at Vicksburg from Yazoo River and tributaries, as reported by the Vicksburg Cotton Exchange, was 35,587 bales.

The Yazoo City Exchange reports 19,598 bales received at that place.

W 13.

IMPROVEMENT OF TCHULA LAKE, MISSISSIPPI.

At the head of Honey Island, about 220 miles above its mouth, the Yazoo River divides into two branches, the westerly one retaining the name of the river, while the easterly and narrower branch is called Tchula Lake or River. The distance from the head to the foot of the island, where the branches again unite, is about 67 miles.

Productive plantations join one another along the banks of the lake, and the amount of cotton raised annually is estimated to be about 20,000 bales, which formerly was brought to market via Tchula Lake and Yazoo River, or hauled in wagons long distances to the southern division of the Illinois Central Railroad. This road has constructed a line from Yazoo City to the mouth of Yalabusha River, which touches Tchula Lake at several points, and has a tap line from Tchula City to the main line at Durant, Miss., and transports most of the cotton, which has to be marketed before navigation opens in the lake.

An examination was made by the United States in 1879, and the project based thereon contemplated the removal of snags, logs, overhanging trees, etc., obstructing navigation, to enable light-draught boats to enter the lake earlier in the season. The estimated cost of such improvement was $10,000, with the idea of doing the work in one low-water season. Twelve thousand dollars have been appropriated, but at such irregular intervals, extending over eight years, that the work never has been completed as projected, and even if once done thoroughly, will have to be gone over from time to time to remove additional obstructions that are forming continually.

Work was begun in 1881, and continued in 1882, 1884, and 1886–'87. Navigation was improved considerably by the removal of overhanging timber, snags, etc., and boats enabled to enter the lake earlier and run much later in the season.

The United States snag-boat *Meigs*, P. R. Starr, master, entered the mouth of the lake February 1, 1889, and commenced operations, working through to the head of Honey Island and then back to the foot of the lake, reaching the latter point February 19. Work was then suspended until the water should reach a stage low enough for a chopping party to commence clearing the banks. The following is a summary of the work performed by the *Meigs:*

Snags pulled		89
Stumps pulled		15
Side jams removed		3
Leaning trees cut		1,138
Leaning trees topped		180
Leaning trees girdled		973
Brush cut from banks	sq. yds.	125

There are three large sand-bars in the lake, one at the head and the others 20 and 50 miles below. The bar at the head is enlarging gradually, and each year the water has to be a little higher before boats can enter that end. Were these bars removed, and the timber and brush thoroughly cleared from the banks, it is probable that the channel would scour to greater depth. I recommend the use of a flat-boat and a large chopping party, to cut brush and leaning trees so as to widen the channel. Logs and stumps can be removed with high explosives. Brush dams at the bars can be built at small expense with material cut in clearing the banks, and a considerable increase of depth obtained by

their aid. It is proposed to apply the available balance to carrying out this work, so far as practicable with that amount. The sum of $6,000 can be spent to good advantage in this way in the low-water season, and the obstructions so thoroughly removed with this amount that no further work would be required for several years to come.

The former appropriations were:

By acts of—	
March 3, 1881	$3,000.00
August 2, 1882	2,500.00
July 5, 1884	1,500.00
August 5, 1886	2,000.00
August 11, 1888	3,000.00
Amount appropriated to June 30, 1889	12,000.00
Amount expended to June 30, 1889	10,278.57

Money statement.

July 1, 1888, amount available	$0.78
Amount appropriated by act of August 11, 1888	3,000.00
	3,000.78
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	1,279.35
July 1, 1889, balance available	1,721.43
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	6,000.00

COMMERCIAL STATISTICS.

When the water is high enough the Yazoo boats go through the lake, but no information as to the number of trips made, and the freights carried could be obtained, although circular letters were sent early in June to the owners of steam-boats and other persons interested in this improvement, asking for such information as they were able to give.

W 14

IMPROVEMENT OF TALLAHATCHEE RIVER, MISSISSIPPI.

The headwaters of this river are in Tippah and Union counties, in northern Mississippi. It flows in a southwesterly direction until joined by Coldwater River in forming Yazoo River.

An examination was made by the United States in 1879. The project based thereon contemplated the removal of snags, sunken logs, and leaning timber obstructing low-water navigation below the mouth of Coldwater, a distance of 165 miles, and the removal of the wreck of the steamer *Star of the West*, lying in the channel 8 miles above the mouth. The estimated cost of such improvement was $40,000. An additional examination was made in 1880 to obtain further information in regard to the river, which demonstrated that any improvement above Sharkey's Landing, about 100 miles above the mouth, would be of little use.

Work was begun in 1879 and continued in 1880, 1881, 1882, 1884, and 1886-'87. Parts of the appropriations of 1880 and 1881 and the entire appropriation of 1882 ($10,000 in all) were expended above mouth of Coldwater to Batesville, as required by the acts. This portion of the river, however, was not included in the original project or estimate of

cost. The work resulted in the removal of a large number of obstructions and greatly increased the capacity of the river for navigation.

Before improvement the river was navigable from the mouth of Coldwater to the Yazoo about six months of the year. Boats from the Yazoo now run to Sharkey's Landing the entire year, but rarely go above that point at any stage, as the amount of commerce is not sufficient to justify the expense of a longer trip. The snag-boat *Meigs* in 1886–'87 placed the river in better condition than ever before known, and river men were well pleased with the work accomplished. Many dangerous obstructions remain, however, the removal of which would benefit navigation greatly. New obstructions are forming continually, and no permanent improvement can be effected.

In the past fiscal year the snag-boat *Meigs*, P. R. Starr master, was employed in this stream May 18–31 and June 13–17. By the latter date the river was rising rapidly, with no prospect of an early fall, and the boat was brought to Vicksburg and laid up. The following obstructions were removed:

Snags pulled	number..	171
Stumps pulled	do....	62
Logs removed from channel	do....	33

Until June 15 the water was at a low stage, favorable to snagging operations, and the *Meigs* worked as high as Williams's wood-yard, 18 miles below Sharkey's Landing, removing tree slides and other obstructions from the channel. As soon as the water falls sufficiently, operations will be resumed, and the available balance will be expended by October.

The snag-boat *Meigs* should be used a short time each year to remove heavy snags, tree slides, and sunken saw-logs, but the appropriation should be large enough to permit the use of shore parties systematically to clear the banks, which are heavily timbered. The estimates for 1891 are:

Meigs, one and one-half months, at $2,200	$3,300.00
Shore party, wages and subsistence, five months, at $1,200	6,000.00
Explosives, tackles, etc	400.00
Office, contingencies, and administration	300.00
Total	10,000.00

The former appropriations were:

By acts of—	
March 3, 1879	$6,000.00
June 14, 1880	9,000.00
March 3, 1881	3,000.00
August 2, 1882	3,000.00
July 5, 1884	3,000.00
August 5, 1886	3,500.00
August 11, 1888	5,000.00
Amount appropriated to June 30, 1889	32,500.00
Amount expended to June 30, 1889	29,548.11

Above mouth of Coldwater, $10,000; below mouth of Coldwater, $19,548.11.

Money statement.

Amount appropriated by act of August 11, 1888	$5,000.00
July 1, 18-9, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	2,048.11
July 1, 1889, balance available	2,951.89

Amount (estimated) required for completion of existing project	$17,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	10,000.00
Sumbitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Full statistics regarding the commerce of this stream could not be obtained. It was navigable the entire year, and boats ran as high as Sharkey's Landing all the time.

The Yazoo and Tallahatchee Transportation Company's steamers, four in number, ranging from 163 to 233 tons, and drawing from 15 to 22 inches light and 4½ to 5½ feet loaded, made 60 round trips to Sharkey's, carrying general merchandise and plantation supplies, and bringing out 7,500 bales of cotton, 16,500 tons of cotton-seed, and miscellaneous freights.

The Pugh Line steamers, of Yazoo City, operate in this trade, running a boat three times a week between Greenwood and Sharkey's, and connecting with the Illinois Central Railroad at the former place. Independent steamers also make occasional trips. No definite information of the amount of business done by these boats could be obtained, although the owners have been asked for it repeatedly. It is estimated, however, that they carried not less than 8,000 bales of cotton and 2,000 tons of seed, besides miscellaneous freights.

During high stages considerable timber is brought out of this river by raftsmen, and a large quantity of staves is shipped to market yearly by this route. Numbers of prosperous little towns are scattered along the banks, all being of more or less importance as shipping points, and having some of the finest cotton-producing lands in the State of Mississippi to support them. The improvement is important, as at present the river is the most available outlet to market, the only other means of transportation being the branch of the Illinois Central Railroad east of Yallabusha River, which is practically inaccessible to planters on the right bank, and would necessitate a haul of from 5 to 25 miles through the swamps and across Yallabusha for those on the left bank.

W 15.

IMPROVEMENT OF STEELE'S BAYOU, MISSISSIPPI.

This bayou has its source in Swan Lake, Washington County, Miss., flows in a southerly direction parallel to the Mississippi River, and enters Yazoo River about 12 miles above its mouth, and generally is not navigable except when the Mississippi is high enough to fill the lower portion with backwater.

An examination was made by the United States in 1883, but the engineer officer in charge reported the stream not worthy of improvement and the work not a public necessity.

The upper part of the bayou and the borders of Lake Washington and Swan Lake furnish the products shipped through it. The lower part is subject to overflow from backwater, and not much land in the vicinity is under cultivation. The west side of Lake Washington is not far from the Mississippi River, and a branch of the Louisville, New Orleans and Texas Railroad extends from Greenville south to Glen Allan, near the Issaquena County line, whence it will be extended to the main line near Rolling Fork this fall. This lies between Swan Lake and Lake Washington, and will absorb much of the carrying trade that otherwise would be tributary to Steele's Bayou.

During 1884–'85, and the latter part of 1886, chopping parties removed obstructions of snags, stumps, leaning timber, etc., so far as the funds available would permit. Operations of the two seasons extended from the head of Washington Bayou, which connects Steele's Bayou and Lake Washington, to the mouth of Steele's Bayou.

In February, 1889, the steamer *Lake Washington* was hired for work in this stream. She left Vicksburg February 11, and proceeded up-stream to near the mouth of Washington Bayou (as far as practicable at the stage of water), working back from that point. The work was performed as thoroughly as circumstances would permit, the boat being compelled to drop down-stream as the water fell to prevent being caught in the bayou without sufficient water on which to retreat. At Eagle Lake Bend the fall began to check, and from there down to 8 miles above the mouth the obstructions were removed more thoroughly. Backwater from the Mississippi prevented further work, and the boat was withdrawn February 26 until a more favorable time.

Overseer J. T. Dorey, who superintended operations, reported the removal of obstructions as follows:

Stumps removed from channel		107
Logs removed from channel		4
Jams removed		4
Side jams removed		3
Shore snags cut		87
Leaning trees cut		381
Leaning trees topped		7
Brush and willows cut	sq. yds.	4,495

The stumps were all large, measuring from 2½ to 4 feet in diameter, and a free use of dynamite was required in their removal.

It is proposed to resume this work and expend the available balance in removing obstructions from the lower part of the bayou as soon as practicable.

If the improvement is to be continued, I recommend that it be done by chopping parties and a small snag-boat. The sum of $5,000 could be spent to advantage in one low-water season in clearing the bayou for high-water navigation.

The former appropriations were:

By acts of—	
July 5, 1884	$2,500.00
August 5, 1886	2,500.00
August 11, 1888	2,500.00
Amount appropriated to June 30, 1889	7,500.00
Amount expended to June 30, 1889	6,829.35

Money statement.

July 1, 1888, amount available	$300.80
Amount appropriated by act of August 11, 1888	2,500.00
	2,800.80
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	2,130.15
July 1, 1889, balance available	670.65
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000.00

COMMERCIAL STATISTICS.

No information in regard to the commerce of this stream could be obtained. The only owner of steamers used in this trade was repeatedly asked for such data as he could give, but paid no attention to the requests.

W 16.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

This river has its source in Mud Lake, Coahoma County, Miss., flows in a southerly direction, and enters Yazoo River about 55 miles above its mouth. During extreme high water it is navigable to Clarksdale, 280 miles above the mouth. Faisonia, 144 miles above the mouth, ordinarily is considered the head of navigation.

An examination was made by the United States in 1878, and the plan adopted for the improvement consisted in building timber and brush wing-dams to scour a channel from 3 feet to 40 inches deep at the bars, and the removal of snags, sunken logs, and leaning timber, obstructing navigation, at an estimated cost of $66,000.

The improvement was begun in 1879, at which time but one boat of 145 tons, and drawing 18 inches of water, navigated the stream. It was navigable then about six months of the year, but a boat could not make the trip under ten and often fifteen days. During the past year boats ran as high as Williams Landing, about 210 miles above the mouth, for two months, Faisonia for four months, Johnsonville for eight months, and Vick's Landing the entire year. The Sunflower River Packet Company has a regular weekly steamer employed in this trade, which makes the trip without difficulty in six days at the lowest stages. Freight rates are reported to be 40 per cent. less than they were before work commenced.

In the past fiscal year operations were not commenced until June on account of unfavorable stages of water. The steamer *Addie E. Faison* was hired of the Sunflower River Packet Company, and entered the river and began operations June 7. This boat continued work below Woodburn until the 22d, when, on account of a continued rise of the lower river, she proceeded up-stream and was employed above Woodburn the remainder of the month. The following summary gives the work performed during the month:

Logs and snags removed from channel	140
Jams removed	3
Side jam removed	1
Leaning trees cut	617
Leaning trees girdled	2

Wing-dams of brush and logs were built at the following shoals: Cypress Bend, mouth of Porter's Bayou, and Pulltight Bar.

The result of this work was to render navigation safe and easy where the logs and jams were removed, and to increase the depth of the channel from 18 to 26 inches where the dams were built.

Should the stage of water be favorable, the steamer will continue this work until the appropriation is expended, which probably will be before August 1. Owing to sliding and caving banks and formation of new bars, the improvement is not permanent, and the sum of $10,000 could be spent to great advantage in a single season in removing logs from the channel, building wing-dams, and cutting leaning timber. Two parties should be worked under a superintendent who has had experience in this kind of work and in handling explosives. The people engaged in business on this river want immediate relief and work of a more lasting character than that of the past. Neither can be had with small appropriations.

The former appropriations were:

By acts of—	
March 3, 1879	$20,000.00
June 14, 1880	8,000.00
March 3, 1881	4,000.00
August 2, 1882	5,000.00
July 5, 1884	5,000.00
August 5, 1886	5,000.00
August 11, 1888	5,000.00
Amount appropriated to June 30, 1889	52,000.00
Amount expended to June 30, 1889	50,243.73

The bridge of the Georgia Pacific Railway across this river near Johnsonville, Miss., authorized by acts of March 3, 1887, and April 2, 1888, was completed in March, 1889, in accordance with plans approved by the Secretary of War.

Money statement.

Amount appropriated by act of August 11, 1888	$5,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	3,243.73
July 1, 1889, balance available	1,756.27
Amount (estimated) required for completion of existing project	14,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The Sunflower River packet steamer of 241 tons, and drawing 16 inches light and 4 feet loaded, made 52 round trips in this stream during the fiscal year. Independent steamers also made occasional trips.

The following down freights were reported by the Sunflower River Packet Company:

Cotton	bales	16,000	Staves	number	28,000
Cotton seed	tons	6,000	Wood	cords	1,400
Hides	pounds	1,400	Logs (rafted timber)	number	2,000
Cattle	head	200	Corn	barrels	1,400
Hogs	do	400	Potatoes	do	1,000
Seed-cotton	sacks	24,000	Poultry	dozen	200

Return freights of general merchandise and plantation supplies. Estimated value, $200,000.

The estimated value of the commerce of the stream at the present time is given at $1,000,000.

The amount of cotton reported by the Vicksburg Cotton Exchange as received from Sunflower River was 5,994 bales. The Yazoo City Exchange reports 1,361 bales received at that place.

W 17.

IMPROVEMENT OF BIG HATCHEE RIVER, TENNESSEE.

This river has its source in northern Mississippi, flows in a northwesterly and then westerly direction, through the most productive region of West Tennessee, and enters Mississippi River about 50 miles above Memphis.

An examination was made by the United States in 1879, and the project based thereon contemplates the removal of logs, snags, leaning tim-

ber, etc., obstructing navigation from Bolivar, Tenn., to the mouth, a distance estimated at 240 miles. This would render the river navigable for light-draught boats throughout the year. The original estimate of cost of this work was $30,000, but this was based upon a plan of four months' work in 1880, at $15,000, three months in 1881, at $10,000, and two months in 1882, at $5,000. In place of this appropriations aggregating $27,000 have been made at irregular intervals, scattered over a period of nine years, increasing the cost and lessening the utility of the work done. In view of the present method of making appropriations it is impossible to give any definite estimate for this class of work, as new obstructions are added from time to time by the leaning timber and logs and snags brought into the stream by each flood.

The work of improvement was begun in 1880, and continued in 1881, 1882, 1884, and 1886–'87. Before its commencement navigation was almost entirely suspended by the obstructions. Now it is navigable about seven months of the year, and the work has benefited commerce in allowing shipments by river where railroads monopolized the trade before.

The last work was performed in June, 1887, and suspended at Rialto, about 60 miles above the mouth. In April, 1889, a chopping party was organized at Rialto under overseer J. T. Dorey, commenced operations April 5, and continued until June 14, when work was suspended by high water, and the party disbanded. This work continued from Rialto upstream, about 55 miles, to a point 2 miles above the Louisville and Nashville Railroad Bridge. The leaning timber felled was cut into short lengths and hauled out on the banks to dry and float off during high water.

The following obstructions were removed:

Logs and snags from channel	1,069
Stumps	339
Side jams	27
Shore snags	818
Leaning trees	1,012
Leaning trees topped	12
Leaning trees girdled	1,729
Square yards of brush cut	4,684

As soon as the snag-boat stops work in Forked Deer River it is intended to tow it into this stream and apply the available balance towards the removal of snags and logs from the channel. The entire amount probably will be expended by October, 1889.

This snag boat was constructed from a pile-driver barge borrowed from Captain Leach, Corps of Engineers, for use in this and Forked Deer River. It is supplied with steam-power, quarters for crew, etc., and by erecting a pair of shears and making a few minor repairs the cost of the purchase or hire of a boat was saved. It answers the purpose admirably, but should it be needed for work on the Mississippi a flat-boat, with necessary appliances for pulling snags and logs buried in the channel, will be required. The removal of these obstructions will enable the current to wash out and deepen the channel at shoal places, and probably lengthen the navigable season at least two to three months. Steam-boat men and others interested in navigation of this stream urge this method of improvement, stating that if the snags are removed thoroughly 3 feet of water at the lowest stages, or navigation for light-draught steam-boats the entire year, will be obtained. Were this done, there is little doubt that the commerce will be much increased and freight rates reduced.

As the stream is over 300 miles above Vicksburg (the office of this district) it is difficult to supervise the work, and expenses of administration are considerable. Economy would be subserved by expending sufficient in one season to put the river in so good a state as not to require work for several years. It costs no more to get ready for six months' work than for six weeks, and the expenses of administration are practically the same for both periods. The work will be much more thorough and the improvement more lasting by such concentration of effort, and the object arrived at—the practical benefit of navigation—more nearly attained. I therefore recommend the expenditure of not less than $10,000 in one season, beginning work as soon as the stage of water will permit, constructing a flat-boat, or hiring one if any can be found at or near Memphis, if the boat now used can not be obtained, and using explosives liberally for removing snags and sunken logs. A shore party, lodged in tents and moving about in skiffs, should clear the banks of brush and leaning timber, and supplement work in the channel or join with the flat-boat party when the water is low. The estimates are as follows:

Construction of boat, or hire for six months, at $300	$1,800
Wages and subsistence of channel and shore parties, six months, at $1,250	7,500
Explosives, repair of tackle, tools, etc	300
Office, administration, and contingencies	400
Total	10,000

The work can be carried on in connection with that on Forked Deer River, so far as regards purchase and delivery of supplies and inspection.

The former appropriations were:

By acts of—	
June 4, 1880	$10,000.00
March 3, 1881	3,500.00
August 2, 1882	3,000.00
July 5, 1884	2,500.00
August 5, 1886	3,000.00
August 11, 1888	5,000.00
Amount appropriated to June 30, 1889	27,000.00
Amount expended to June 30, 1889	23,989.02

Money statement.

Amount appropriated by act of August 11, 1888	$5,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	1,989.02
July 1, 1889, balance available	3,010.98
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

COMMERCIAL STATISTICS.

This stream was navigable for seven months of the past fiscal year, from December to June, inclusive. Two small steam-boats, of 65 and 75 tons, drawing 14 and 18 inches light and 3 and 3½ feet loaded, made six trips with barges, and a tug with barges made two trips. No information of the business done could be obtained.

W 18.

IMPROVEMENT OF FORKED DEER RIVER, TENNESSEE.

Main Forked Deer River, 24 miles long, is formed by the confluence of the North and South Forks about 9 miles below Dyersburgh, flows in a general southwesterly direction, enters Obion River 4 miles above its mouth, and thus finds an outlet to the Mississippi. The mouth of the stream was formerly at Ashport, on the Mississippi River, but about 50 years ago the State cut a canal through to the Mississippi (now Obion River) to shorten the course.

The old channel is now blocked up with drift. North Fork is formed by several smaller streams near Trenton, in Gibson County, flows in a westerly direction to Dyersburgh, and thence southwesterly. South Fork heads in McNairy and Henderson counties, and flows in a general northwesterly direction to its junction with North Fork.

Examinations were made by the United States in 1874, 1880, and 1887, and the project, based upon the two latter, contemplated the removal of snags, logs, leaning timber, etc., to improve navigation in South Fork below Jackson, in North Fork below Dyersburgh, and in the main river. The estimated cost for South Fork was $19,250, and for North Fork and main river, $11,500. These estimates were based upon plans for a single season's work, and as new obstructions are added from time to time it is probable that the cost will be increased.

All appropriations prior to the act of 1888 were for the improvement of South Fork alone. The removal of obstructions from this branch of the river was begun in 1883 and continued in 1884 and 1886–'87, $10,000 having been expended to June 30, 1888. The commerce consists chiefly of staves and lumber, brought out on flat-boats, and saw-logs, rafted to market. Before the improvement commenced, about one boat in three was lost by reason of the obstructions. Now they make the trip with comparative safety and at a cost of from $200 to $300 less than in former times.

The river and harbor act of August 11, 1888, made a general appropriation for improving Forked Deer River, with designated amounts to be applied to each branch, as follows:

South Fork	$2,500
North Fork below Dyersburgh	4,500
Main river below	2,500

Operations of the past fiscal year have been carried on under the superintendence of J. T. Dorey, and were as follows:

A boat with steam-power being necessary for removal of obstructions in the channel, a pile-driver barge, supplied with engine, quarters for crew, etc., was borrowed in October from Captain Leach, Corps of Engineers, and by fitting up shears and making some minor repairs, the cost of purchase or hire was saved to the improvement. This snag-boat was propelled by hand, and has been used to advantage in all three branches of this stream.

SOUTH FORK.

A chopping party commenced operations in this fork early in December, near the brush-dam below Bell's Depot, where work was suspended in 1887. By means of explosives a channel 100 feet wide was cleared

through this dam, and no further trouble will be caused by it. Shore-work was continued up-stream to Jackson, and thence back to the mouth, reaching the latter point March 9. With the exception of a temporary suspension of ten days, the latter part of January, caused by a sudden rise, this work was carried on continuously.

The snag-boat worked in this fork April 1–17, expending the available balance in removing the most serious channel-obstructions and cutting the leaning timber near the mouth. The distance worked over was 8 miles. The channel is narrow, and the trees inclined from both banks until in many places their branches interlaced. These were hauled out on the banks, destroyed, and their stumps removed with explosives.

The following summary shows the obstructions removed during the past year:

Snags and logs		460
Stumps		90
Jams		29
Side jams		63
Shore snags		360
Leaning trees cut		991
Leaning trees topped		181
Leaning trees girdled		105
Brush and willows cleared from banks	sq. y'ds..	2,180
Wreck (stave-boat)		1
Linear feet brush-dam		100

NORTH FORK, BELOW DYERSBURGH.

A chopping party commenced work at the mouth of North Fork October 3, and completed the principal shore-work needed by November 27.

Obstructions were heavy, numerous, and difficult to remove, consisting chiefly of badly-leaning timber. In many instances trees from caving banks had fallen into the stream, forming rack-heaps almost buried in the mud. From time to time rivermen have sawed off large cypress trees which stood in the channel, leaving stumps from 3 to 6 feet in diameter standing 2 to 5 feet above low water. These were removed with explosives. Most of the obstructions had to be cut in short lengths and hauled out on the banks to get rid of them effectually.

Channel-work was commenced with the snag-boat December 6, and continued, when the stages of water would permit, until the end of May, the time employed being as follows: December 6 to January 7, March 18–31, and April 18 to May 31. The low-water channel for the entire distance was badly obstructed by stumps, snags, and sunken logs firmly wedged together, and trees which had caved from the banks and fallen across the stream. In many places these allowed only from 8 to 12 inches of water in the channel, and as the snag-boat drew about 2½ feet it was necessary to remove them to that depth before it could pass up. On account of the river being narrow (the average width being 85 feet) and the banks generally high, the work was slow and laborious, as it was necessary to pull all snags and logs out on the banks to prevent their becoming obstructions again. On the return from Dyersburgh to the mouth a good channel had scoured at nearly every place where the obstructions had been removed, and the boat did not touch, except at a few points near the mouth, where the water had been too high to perform effectual work on the way up. These obstructions were removed, and at present there is a good channel in North Fork to Dyersburgh, with a least depth of 2½ feet at ordinary low stages.

The following obstructions have been removed from North Fork during the year:

Snags and logs		1,067
Stumps		385
Side jams		15
Shore snags		676
Leaning trees cut		845
Leaning trees topped		81
Brush and willows cleared from banks	sq. yds.	926
Wreck (old steam-boat from channel below Dyersburgh Landing)		1

MAIN RIVER.

The pile-driver barge borrowed of Captain Leach was towed to the mouth of Obion River October 25. From there up to Forked Deer River (4 miles) the boat was propelled by the crew, and the work of repairs, overhauling machinery, etc., begun at once. These were completed November 10, and the boat was worked up to mouth of North Fork, reaching there November 22. Continued high water prevented further work until June 10, at which date the snag-boat resumed operations, but was interrupted by another rise June 23.

The following obstructions were removed in November and June:

Shore snags		70
Side jams		9
Leaning trees cut		324
Leaning trees topped		29
Leaning trees girdled		174
Brush cleared from banks	sq. yds.	500

The amounts expended during the year are as follows:

South Fork	$2,500.00
North Fork below Dyersburgh	3,862.85
Main River	1,616.36
Total	7,979.21

The balances available for North Fork and the main river will be applied to continuing the removal of obstructions during the present low-water season, and will be expended by the middle of September.

South Fork is obstructed by numerous bridges without draws, heretofore reported, which render steam-boat navigation impracticable.

Commerce is carried on by flat-boats and barges, and for the present no additional funds are required for further improvement. The work of the past year has put North Fork in fairly good navigable condition, and nothing further should be required in it for several years, or at least until the main river has been put in equally good condition. For the latter purpose $5,000 can be expended profitably in the fiscal year ending June 30, 1891.

The former appropriations were:

By acts of—	
August 2, 1882	$3,000.00
July 5, 1884	2,000.00
August 5, 1886	5,000.00
August 11, 1888	9,500.00
Amount appropriated to June 30, 1888	19,500.00
Amount expended to June 30, 1888	17,979.21

Money statement.

Amount appropriated by act of August 11, 1888	$9,500.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	7,979,21
July 1, 1889, balance available	1,520.79

Amount that can be profitably expended in fiscal year ending June 30, 1891 $5,000.00
Submitted in compliance with the requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

South Fork was reported navigable about four months for the past fiscal year. Commerce is carried on during high stages only, and consists chiefly of staves and lumber brought out on barges and rafts of logs. No information as to quantities could be obtained.

North Fork was navigable to Dyersburgh between four and five months only, the obstructed condition of the main river having prevented boats running longer. One small steam-boat of about 75 tons, drawing 18 inches light and 4 feet loaded, made twenty round trips between Memphis and Dyersburgh, and tow-boats with barges, etc., made occasional trips to Dyersburgh, but no definite information of quantities of freights carried could be obtained. Dyersburgh is a town of about 3,000 inhabitants, has several stave factories, saw-mills, planing-mill, flour-mill, oil-mill, machine-shops, and tobacco factory, and a cotton compress now building.

The business of this place for the fiscal year as reported by the town officials, was as follows:

Cotton ..... bales..	25,000	Hogs ..... head..	5,000
Cotton seed ..... tons..	5,000	Staves ..... number..	6,200,000
Cotton-seed oil ..... barrels..	1,600	Lumber ..... feet B. M..	7,000,000
Cotton-seed meal ..... tons..	800	Corn ..... bushels..	20,000
Cattle ..... head..	2,000	Tobacco ..... hogsheads..	500

This includes both railroad and river freights, and they estimated that about one-quarter of the above was shipped by river. My assistant regards these estimates as too large. He reports that during the time the steam-boat was able to run over 4,000 bales of cotton was shipped at rates as low as 60 cents a bale. Of this quantity the boat carried about 800 bales and the railroad the remainder. As soon as the steamer stopped running, the railroad resumed its former rate of $1.45 per bale.

Main river has but three landings from the junction of the forks to its mouth, and is of importance only as an outlet for the trade from above. During the year about 180,000 staves, 2,000 saw-logs, and 400 cords of wood were brought out.

W 19.

WATER-GAUGES ON THE MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

These gauges were established under joint resolution of Congress, approved February 21, 1871 (section 5252, Revised Statutes), reading as follows:

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and is hereby authorized and directed to have water-gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries, at or in vicinity of St. Louis, Cairo, Memphis, Helena, Napoleon, Providence, Vicksburg, Red River Landing, Baton Rouge, and Carrollton, on the Mississippi, between the mouth of the Missouri and the Gulf of Mexico, and at or in vicinity of Fort Leavenworth, on the Missouri; Rock Island, on the Upper Mississippi; Louisville, on the Ohio; Florence, on the Tennessee; Jacksonport, on the White River; Little Rock, on the Arkansas; and Alexandria, on the Red River; and such other points as the Secretary of War may deem advisable; the expenditure for the same to be made from the appropriation for the improvement of rivers and harbors: *Provided*, That the annual cost of the observations shall not exceed the sum of five thousand dollars per annum.

The special objects for which the gauges were designed were to secure information from continuous records, with a view to reclaiming

the alluvial basin of the Mississippi from overflow, and to give reliable reports for the benefit of river men and planters.

The gauges were established by Maj. William E. Merrill, Corps of Engineers, during the latter part of 1871, except that at Carrollton, established in January, 1872. The resolution of Congress called for seventeen gauges, but nineteen were actually established; an extra one at Louisville, as gauges were required both at the head and foot of the falls, and one at Natchez, Miss., which was specially requested by the river interest. Another change from the designated localities was the establishment of a gauge at the mouth of White River instead of Napoleon, the reason for the change being that half of Napoleon had then been washed away (since all destroyed), including all the old bench-marks, and the mouth of White River was considered the most desirable point in that vicinity and of greatest convenience to the steamboat interest.

An additional gauge was established by Major Merrill at Nashville, Tenn., on the Cumberland River, in August, 1873.

The gauge at Rock Island, Ill., was discontinued by Captain Benyaurd April 30, 1879, for the reason that the appropriation pertained more particularly to the Lower Mississippi and its tributaries, and observations so far north were not needed.

The old gauge at Fort Leavenworth, Kans., was abandoned November 30, 1886, and the one belonging to the Missouri River Commission used in its place, payment for observations being made by this office, and the inspection and repairs continued by the Commission.

In 1881 bulletin-boards were erected at all stations on the Mississippi, and one at Alexandria, on Red River, in 1887, for the purpose of giving to steam-boats the stage of water at each reading. A full description of these bulletins will be found in the Report for 1881.

To secure greater uniformity and accuracy the gauges have been read and bulletins changed at 8 a. m. and 4 p. m. daily since February 1, 1887; formerly they were read at 8 a. m. only.

The gauges are used by the Signal Service at the following stations: St. Louis, Mo.; Nashville, Tenn.; Cairo, Ill.; Memphis, Tenn.; Helena, Ark.; Vicksburg, Miss., and Alexandria, La.

The following is a list of the appropriations made for this work:

Allotments from general appropriations for examinations, surveys, and contingencies of rivers and harbors:	
By acts of—	
March 3, 1871	$5,000.00
June 10, 1872	5,000.00
March 3, 1873	5,000.00
June 23, 1874	5,000.00
March 3, 1875	5,000.00
Specific appropriations in river and harbor acts:	
August 14, 1876	5,000.00
June 18, 1878	5,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 1881	5,000.00
August 2, 1882	5,000.00
Deficiency appropriation:	
March 12, 1884	2,100.00
Specific appropriations in river and hart or acts:	
July 5, 1884	5,000.00
August 5, 1886	5,000.00
August 11, 1888	8,700.00
Amount appropriated to June 30, 1889	75,800.00
Amount expended to June 30, 1889	74,233.71

The act of August 11, 1888, appropriated $9,600, but an allotment of $900 was made September 29, 1888, to Maj. Charles J. Allen, Corps of Engineers, to comply with requirement of this act in the paragraph relating to reservoirs at the headwaters of the Mississippi, which directed that the Secretary of War should "cause such gangings to be made at or near St. Paul during the annual operation of said reservoirs as shall determine accurately the discharge at that point, the cost of same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries."

During the fiscal year observations were continued at all the stations. Records of the daily readings have been furnished the Secretary of the Mississippi River Commission, and a copy of the Carrollton record has been furnished the assistant engineer at South Pass of the Mississippi River.

The value of the records depends both on the accuracy of the readings and the accurate positions of the gauges, which should be checked frequently by reference to established benches, as even those called permanent are subject to motion from the instability of the banks. An inspector should make a complete tour nearly every month, with level and rod and appliances for minor repairs, but as the amount applicable for this purpose is too small to hire an assistant engineer continuously, and as the Mississippi River Commission has established additional gauges at various points on the main river and tributaries, inspections have been carried on by distributing the expenses between this office and officers in charge of districts on the Mississippi River. As soon as practicable after the passage of the act of August 11, 1888, Asst. Eng. C. W. Clark (employed under the Secretary of the Commission) was sent out to inspect all the gauges, no inspection or repairs having been made since December, 1887, by reason of lack of funds. The following gauges were inspected by him:

August.—(21st) Cairo, Ill.; (25th) Memphis, Tenn.; (27th) Helena, Ark.; (29th) Jacksonport, Ark., and (30th) Little Rock, Ark.

September.—(3d) Mouth of White River, Ark.; (5th) Vicksburg, Miss.; (7th) Lake Providence, La.; (8th) Natchez, Miss.; (9th) Red River Landing, La.; (10th) Baton Rouge, La.; (11th) Carrollton, La.; (13th) Alexandria, La.; (17th) Nashville, Tenn.; (18th) Louisville, Ky., and (22d) St. Louis, Mo.

The gauges at mouth of White River, Lake Providence, Red River Landing, and Alexandria were repaired so far as practicable at the stage of water and with the material at hand. The gauge at Florence was not inspected, as the assistant was unable to reach that point on account of quarantine regulations then existing by reason of yellow fever in the South. Since this tour Mr. Clark's services have been required wholly upon the work under the Secretary of the Commission. In December I obtained permission of Captain Kingman to allow Assistant John Ewens to inspect the gauges under my charge from time to time, when he could be spared from his other duties, and the following have been inspected and repaired by him during the year:

January.—(7th) Red River Landing, La., gauge rebuilt and bulletin painted.

February.—(7th) Natchez, Miss.; (8th) Red River Landing, La.; (19th) Alexandria, La., gauge rebuilt from 20-foot mark to 37-foot mark; (20th) Baton Rouge, La., gauge rebuilt from 30.4-foot mark to 40-foot mark; (25th) Carrollton, La., gauge rebuilt from zero to high-water mark.

Mr. Ewens was formerly employed under the secretary of the Missis-

sippi River Commission and by me on this work, and is well acquainted with all the gauges, bench-marks, etc. I am well satisfied with the way he performs the duties of inspection, and have arranged for him to visit all the gauges and put them in thorough repair. This should be done at low stages, and as the Mississippi and most of the tributaries have remained high it has not been practicable at any time since the appropriation became available.

Below is given a statement of expenditures made during the fiscal year:

Payments made for expenses of fiscal year ending June 30, 1888.

[Authorized by act of August 11, 1888.]

Gauge-keeper's wages	$2,626.27
Office expenses	150.00
Mileage	35.20
Removing sediment deposits from gauge at Baton Rouge, La	22.70

Payments made for expenses of fiscal year ending June 30, 1889.

Gauge-keeper's wages	3,180.00
Pay of inspector	250.00
Traveling expenses	207.35
Office expenses and stationery	592.50
Field glass for use at Little Rock gauge	8.00
Repairs of gauges, bulletins, etc	31.40
Telegrams	1.00
Printing gauge records	39.93
Total expenditures during fiscal year ending June 30, 1889	7,144.35

Had the stage of water been favorable, it is probable that the available balance would have been expended for repairs of gauges and bulletins and pay and traveling expenses of the inspector.

From the beginning the amounts allotted for these gauges have not been sufficient, as may be seen by reference to the early reports of Major Merrill. Although the resolution of 1871 seemed intended to provide an annual appropriation of $5,000 (which was too small), even this amount has not been available, as the resolution directed that the expenditure should be made from the appropriation for the improvement of rivers and harbors, which of late years could hardly be considered an annual appropriation. In 1878 observations had to be stopped for want of funds, but many observers continued the readings without compensation. In 1886, no appropriation being made for that fiscal year, the Mississippi River Commission paid the observers and made necessary repairs of gauges on the Mississippi to prevent suspension of those important observations. In 1884 a deficiency appropriation was made for their continuance, and the observations of the fiscal year 1887–'88 would have been suspended had it not been for the voluntary action of the observers reported last year.

Unless the records are continuous they are of very little use, and for this reason the act of August 11, 1888, made permanent appropriation for the work as follows:

SEC 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries as provided for in joint resolution of the twenty-first of February, eighteen hundred and seventy-one, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount apppropriated in this act for such purpose: *Provided, however*, That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers.

The following table gives the elevations of the gauge zeros, so far as has been determined:

[Authority: Mississippi River Commission.]

Gauge.	Elevation of zero above Cairo datum.	Gauge.	Elevation of zero above Cairo datum.
	Feet.		*Feet.*
St. Louis, Mo	400.23	Vicksburg, Miss	66.64
Cairo, Ill	296.84	Natchez, Miss	36.89
Memphis, Tenn	203.97	Red River Landing, La	22.85
Helena, Ark	161.96	Baton Rouge, La	20.06
Mouth White River, Ark	128.73	Carrollton, La	20.91
Lake Providence, La	89.62		

Cairo datum is a plane 300 feet below the reading 9.16 feet on the Cairo gauge. The preliminary elevation of mean Gulf level at Biloxi, Miss., is 21.26 feet, but this has not been finally adopted and may yet receive correction. (See Report of Mississippi River Commission for 1885, page 2900.)

By deducting 21.26 from the elevations given above *the approximate* elevation of the zeros of the gauges above mean tide at Biloxi, Miss., may be determined.

Efforts are being made to obtain the elevations of the gauge zeros on the tributaries.

It is recommended that additional gauges be established on Red River, at Fulton, Ark., Garland, Ark., and Shreveport, La. The cost of erecting these gauges will be about $400, and the annual charge for keeper's pay and maintenance about $400.

Money statement.

Amount appropriated by act of August 11, 1888		$9,600.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$7,133.71	
July 1, 1889, amount allotted for gaugings at St. Paul	900.00	
		8,033.71
July 1, 1889, balance available		1,566.29
Amount that can be profitably expended in fiscal year ending June 30, 1891		9,600.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

W 20.

PRELIMINARY EXAMINATION OF BOGUE PHALIA, MISSISSIPPI, ESPECIALLY THE PART KNOWN AS THE NARROWS, WITH VIEW TO ITS IMPROVEMENT.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., February 12, 1889.

SIR: I have the honor to report a preliminary examination of Bogue Phalia (Miss.), especially that part known as the narrows, with view to its improvement, as provided in the law of August 11, 1888, making appropriations for rivers and harbors. The examination was made in December, 1888, by Assistant Engineer H. M. Marshall, who reports as follows:

This bayou having its source in three prongs, which begin in the north edge of Bolivar County, Miss., just south of the ridge which forms the water-shed be-

tween this bayou and Hushpuckena, flows south into Washington County, and in the southern part of the county turns east, emptying into Sunflower River. From the juncture of the prongs to the head of the narrows, a distance variously estimated from 35 to 50 miles, the bayou is virtually a lake 200 feet wide and 20 feet deep at low water. The banks are low, but seldom overflow, except from breaks in the Mississippi River levees, the oscillation from rain being about 8 feet. At the head of the narrows there is a raft, or jam, 300 feet long, and 2 miles below 100 feet long, and one 200 feet long a mile still lower down. From the head of the narrows to the mouth of Clear Creek, the distance is 20 miles, and the bayou is from 40 to 75 feet wide, and from 1 foot to 6 feet deep. The channel is very crooked, filled with logs and drift jams, divided in three places by small tow-heads, besides a chute leaves the bayou a mile below the head of the narrows and returns about 3 miles above the mouth of Clear Creek. The banks are very low, composed of clay and subject to overflow. From the mouth of Clear Creek to the mouth of Bogue Phalia is 60 miles, and along the upper 45 miles the bayou is wide and deep, but narrow, swift, and shallow along the lower 15 miles, where it is crooked and divided by small tow-heads. The banks are high and sandy, being above overflow, but subject to caving where cleared of timber. Above the narrows there is a large amount of cleared land, though a good deal that was formerly in cultivation was abandoned during the overflow in 1882, and is just now being reclaimed. It is estimated that there are 4,000 bales of cotton raised annually in this section and now hauled to landings on the Mississippi River or stations on the Louisville, New Orleans and Texas Railroad, the haul being from 5 to 20 miles. The country adjacent to the narrows is unimproved, being nothing but swamps and canebrake. Below the narrows the land is being rapidly opened. Of the 75 or 100 cabins on the banks, scarcely one is a year old. The country is being developed almost entirely by negroes. One said he could scarcely make a living in the hills, while in two years since he moved he had cleared 150 acres of land and bought and paid for a wagon and four mules. The Louisville, New Orleans and Texas Railroad crosses the bayou 10 miles below the narrows and gradually diverges to the northeast and southwest. The distance from the railroad to the bayou is, at Cleveland, 15 miles; Shaw's, 5 miles; Helm, 1 mile; Leland, 6 miles; Burdette, 4 miles; Arcola, 2 miles. From Shaw's to Arcola is 25 miles by the railroad, and from a point on Bogue Phalia opposite Arcola to a point opposite Shaw's is 60 miles by the bayou, leaving 20 miles of the lower end and 40 miles of the upper that is not adjacent to the railroad. It is but fair to say, however, that the roads to the railroad become impassable after rains. A wagon which had started from the bayou one Saturday with a load of cotton, being overtaken by a heavy rain, had not reached Shaw's station, 5 miles away, the following Wednesday, though the driver labored daily. The Georgia Pacific Railroad crosses the bayou 4 miles below the Louisville, New Orleans and Texas crossing. The bridges on both roads are frame trestles, with bents 12½ feet apart. The authorities of Washington County are constructing a pile bridge across the bayou opposite Arcola. A small steam trading-boat and a boat with a gin on board, ply above the narrows, but they are the only ones running on the bayou. Previous to the building of the Louisville, New Orleans and Texas Railroad and Georgia Pacific Railroad branch, down Deer Creek, boats went up Bogue Phalia to bring down cotton hauled over from Deer Creek and to take up supplies to the planters. There is now no commerce on Bogue Phalia, and no record of former commerce is obtainable, but, without doubt, ten years hence there will be at least 25,000 bales of cotton, worth $750,000, produced annually on its banks. Below the narrows all leaning trees, snags, and logs could be removed for $100 a mile, or $6,000. It would cost each railroad $10,000 to change their bridges to let boats through, and Washington County nearly as much for its bridge. Through the narrows it would cost $250 a mile to clear the banks and remove the logs, jams, and snags, or $5,000 for the reach. Very small boats could, with some trouble getting round the bends, then ply from the time autumn rains begin till late in the spring. Very little is needed above the narrows, and $1,000 would clear it all. To improve the narrows so as to allow boats 100 feet in length, drawing 3 feet water, to run, would require the bayou to be widened and straightened, which would take a deal of dredging, for which no estimate of cost can be made without a survey.

In view of the information given above, I have to report that, in my opinion, Bogue Phalia is not worthy of improvement, and the work is not a public necessity. No further surveys or examinations are considered necessary.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

W 21

PRELIMINARY EXAMINATION OF BAYOU DORCHEAT, LOUISIANA, FROM LAKE BISTENEAU TO THE ARKANSAS LINE.

UNITED STATES ENGINEER OFFICE
Vicksburg, Miss., February 12, 1889.

SIR: I have the honor to report upon the preliminary examination of Bayou Dorcheat, from Lake Bisteneau to the Arkansas line, as provided in the law of August 11, 1888, making appropriations for rivers and harbors. The bayou was examined by Major Miller in 1882, who reported that the system, comprising Loggy Bayou, Lake Bisteneau, and the Dorcheat, was "navigable at high water for the boats that run to Shreveport, and was good for about five months in the year. To attempt to improve the navigation so as to render it good for two more months would involve an expense not justified by the amount of commerce benefited," and that the stream was "not worthy of improvement, nor the work a public necessity."

The act of July 5, 1884, appropriated $5,000 for the improvement of this stream, and Captain Bergland reported that the result of the expenditure had put these streams in "fairly good condition for high-water navigation, which lasts about six months during the year. To lengthen the navigable season, dredging of bars and narrow places occasioned by slides would be necessary. It is doubtful whether the demands of commerce would justify the great expenditure necessary for such improvement." No further appropriations have been recommended for this system. Assistant Engineer H. M. Marshall made an examination of the bayou last November and reports as follows:

This part of the bayou lies wholly in Webster Parish, and its only tributaries are insignificant creeks and spring branches. The bayou is made up of a succession of lakes and lakelets from 50 to 300 feet wide, 10 to 25 feet deep, and from a quarter to 5 miles long, connected by innumerable small channels, varying in size between a rill which loses itself in the low ground and a rivulet that is past fording. The channels are so circuitous that they sometimes rejoin in almost diametrically opposite courses. The lakes are open and offer few obstructions to continuous navigation, and constitute about one-third of the 65 miles of the bayou under consideration. Sikes Lake, beginning about 6 miles below the State line and having a length of 5 miles, is the largest, and Wallace Lake, 4 miles long, about 12 miles further down, is next in size. The banks of the lakes are generally high, though subject to overflow, the hills coming to the bayou on the west only at Wallace Ferry on Wallace Lake, and on the east at Miller's Point, 12 miles above Minden. The overflowed bottom is everywhere about a mile wide. Between the lakes the banks are low and ill-defined, overgrown with trees and bushes, and subject to deep overflow. The numerous channels are filled with logs caught against the cypress trees which grow immediately in the beds. Below Miller's Point for 3 miles the trees and cypress knees completely obstructed the passage of even a small bateau, and in other places over shorter reaches the boats had to be abandoned, the stage of water being 4 feet above minimum. The fall is small, not over 15 feet in the total distance, and concentrated entirely between the lakes. If the water was confined to one channel, boats would have no trouble in going above whenever they could get to Murrell's Point. The oscillation is about 15 feet and the high-water period extends over two to five months in a year.

In 1859 the State of Louisiana had the bayou examined by its engineer board, and appropriated $5,000, which was expended in clearing out the lower 15 miles.

It may be of interest to know that the name was originally Dorchite.

In 1882, Major Miller, U. S. Army, had an examination made of Loggy Bayou, Lake Bisteneau, and that part of Dorcheat from Lake Bisteneau to Murrell's Point, about 17 miles, which point was always considered the head of navigation. He reported it unworthy of improvement, but $5,000 was appropriated by act of Congress approved July 5, 1884. This was expended in clearing the bayous and lake over the whole reach, as well as the amount would permit; but nothing further has been done.

The Saint Louis, Arkansas and Texas Branch Railroad to Shreveport parallels the bayou 25 miles away on the west. The Vicksburg, Shreveport and Pacific Railroad

crosses the bayou on a draw-bridge 9 miles above its mouth. At Murrell's Point a public road crosses on a fixed bridge. From the superintendent of the Vicksburg Shreveport and Pacific Railway, it is learned that one boat made 36 trips through the bridge between January 14 and June 17, 1885; but no boat has passed since.

Minden, La., 3 miles from Murrell's Point, has a compress which handles about 15,000 bales of cotton; but as it is connected with the Vicksburg, Shreveport, and Pacific Railroad at Sibley, by a branch railroad 5 miles long, all the cotton is shipped by rail.

It is claimed that about 10,000 bales of cotton are raised annually within 10 miles of the Dorcheat above Minden, but the census reports 6,255 bales in 1879 for all of Webster Parish.

There is no commerce now of any kind on the Dorcheat, and never was any above Murrell's Point. If the bayou was cleared out doubtless boats would navigate it in time of high water, and every year large quantities of timber would be brought out, both as rafts and sawed lumber. The country abounds in the finest timber for all purposes, from shoe-pegs to ship-building.

No estimate can be made of the cost of improvement to afford continuous navigation without an elaborate survey, but high-water navigation could be attained for 4 months in the year by clearing the timber, at a cost of $250 a mile, or $16,250 for the whole 65 miles.

From previous reports, and from the report of Assistant-Engineer Marshall, I have to say that I do not consider Bayou Dorcheat worthy of improvement, nor the work a public necessity. No further surveys or examinations are considered necessary.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

W 22.

PRELIMINARY EXAMINATION OF OUACHITA RIVER, LOUISIANA AND ARKANSAS, FROM ITS MOUTH TO HEAD OF NAVIGATION, TO DETERMINE THE ADVISABILITY AND PROBABLE COST OF ITS PERMANENT IMPROVEMENT.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., February 12, 1889.

SIR: I have the honor to report upon the preliminary examination of "Ouchita River, Louisiana and Arkansas, from its mouth to head of navigation to determine the advisability and probable cost of its permanent improvement," as provided in the law of August 11, 1888, making appropriations for rivers and harbors.

An examination of this stream from Rockport, Ark., to the Louisiana line was made in 1870, and a survey from Camden, Ark., to Trinity, La., in 1871 under Lieut. Col. Raynolds. The notes of the survey were reviewed by Colonel Simpson's assistants in February, 1873, who condemned the survey and recommended that it be done over. This was ordered by the Department and completed by Major Benyaurd in 1874.

The original plan recommended improvement by locks and dams at an expense of from $3,000,000 to $6,000,000, with timber or stone locks. Major Benyaurd advised that this costly scheme should be abandoned, and submitted the project under which operations are now conducted. This project contemplates the removal of wrecks, logs, snags, leaning timber, etc., and the improvement of shoal places between Camden, Ark., and the mouth of Black River, a distance of about 370 miles. No estimate for permanent improvement can be made as new obstructions are forming continually by falling timber.

Major Miller made further examinations of Ouachita River in 1882 and 1883, and reported the stream as "worthy of improvement, and the work a public necessity and *should be continued as heretofore.*"

Captain Bergland reported in 1885 as follows:

The work heretofore done has greatly benefited navigation by the removal of obstructions, and some of the shoal places have been increased in depth from 12 inches to over 3 feet at low water. Previous to any improvement large boats plied between New Orleans and Camden about half the year. These boats now run to Camden from seven to eight months in the year, and smaller boats run to Monroe, La., during the entire year.

I made an examination of the river from Monroe to Camden in March, 1887, and in June had the river from Arkadelphia to Camden examined by Assistant Engineer Coppée. I was unable to find any argument in favor of an expensive system of improvement by locks and dams, and recommended that the present system be followed, extending the operations to Arkadelphia. The upper section from Arkadelphia to Camden was added to Ouachita and Black rivers in the last appropriation, and a liberal amount ($9,000) granted to complete the work as advised in my report. So far as the upper section is concerned then, I think nothing further should be required for some years. I am still of the opinion that the adopted plan of operations below Camden should be continued. In the absence of an elaborate survey of the whole valley of the Ouachita, it would be mere guess-work to say what the ultimate cost of a slackwater system would be. The estimates heretofore given were either based upon a survey that was condemned, or upon plans that contemplated only a portion of the river, and were deemed out of all proportion to the commerce to be benefited. A survey of the character required would be a very expensive undertaking, and could not be justified unless there were a strong probability that a plan involving an expenditure of at least $3,000,000 should be authorized, with an annual charge for removing logs, snags, etc., and for maintenance at least equal to the appropriations granted heretofore. Having the maps and notes of the early surveys and the reports on Ouachita River at hand, I assigned the duty of examining them to Assistant Engineer H. M. Marshall, who reports as follows:

DESCRIPTION OF THE RIVER.

The Ouachita rises in Polk County, Ark., flows east through Montgomery and Garland counties into Hot Springs, turns southwest and runs into Clark County to Arkadelphia, where it turns and runs nearly south 76 miles through Clark and Ouachita counties to Camden; thence southeast 114 miles to the Louisiana State line, bordered by Calhoun, Bradley, and Ashley counties on one side, and Union County on the other. From the State line it flows east of south between Union and Morehouse parishes, into Ouachita parish, passes the town of Monroe, and through Caldwell and into Catahoula parish to the town of Trinity, 180 miles, where it unites with Tensas and Little rivers, forming Black River. Its principal tributaries are, on the east, Saline River, midway between Camden and Monroe; Bayou Bartholomew, 27 miles above Monroe, and Boeuf River, 8 miles above Harrisonburgh; on the west, Little Missouri River, 43 miles below Arkadelphia, and Bayou d'Arbonne, 6 miles above Monroe.

EXTENT, CHARACTER, AND RESOURCES OF COUNTRY DRAINED.

It drains nineteen counties in southern Arkansas and ten parishes in Louisiana, covering a country 200 miles long and averaging 50 miles wide. Of these 6,400,000 acres, only about 15 per cent. is in cultivation, leaving an unproductive remainder capable of producing half as much cotton as is now raised in all America. The country is upland, with bottoms of varying widths contiguous to the river and its tributaries. The soil is thin, except in the bottoms, which are subject to inundations. Above Ouachita City the lowlands are very little cultivated, but below there are considerable plantations. Both iron and coal are found on the upper river, and there is an iron mine 20 miles below Arkadelphia, and a coal mine 17 miles above Camden. The

timber, consisting of pine, oak, and cypress, forms the most valuable natural resource.

POPULATION, PRODUCTS, AND COMMERCE.

The eight counties in Arkansas and eight parishes in Louisiana which would derive most benefit from continuous navigability of the Ouachita, had in 1880 a population of 161,000. They raised farm products to the value of $10,000,000, in which are included 170,000 bales of cotton valued at $6,000,000. Thirteen steamboats of from 100 to 1,200 tons burden make about eighty round trips in a season. Three of them run from St. Louis, Mo., to Monroe, La., and the others from New Orleans. In addition to the above, sixteen smaller steamers run in the local trade. The following is an average of the down freight in a year:

Cotton	bales..	87,492	Moss	bales..	178
Cotton seed	sacks..	134,352	Sugar	hhds..	75
Cotton-seed meal	do....	6,005	Molasses	bbls..	276
Cotton-seed oil	bbls..	1,404	Cattle	head..	212
Staves	number..	500,000	Hogs	do....	152
Logs	do....	120,000			

The return freight is valued at $3,600,000. The report of the Chief of Statistics for the Treasury Department for 1887 says, in regard to commerce on the Ouachita "Despite railroad competition the Ouachita boats have done and continue to do a large business, and have lost relatively less of the cotton trade of their section than most of the other river lines." Again: "But the excessive insurance rate has operated unfavorably and had a tendency to drive business away."

RAILROAD COMMUNICATION.

The St. Louis, Iron Mountain and Southern Railroad crosses the Ouachita at Arkadelphia on a fixed bridge, the St. Louis, Arkansas and Texas at Camden on a draw-bridge, and the Vicksburg, Shreveport and Pacific at Monroe on a draw-bridge. A branch of the St. Louis, Iron Mountain and Southern runs from Gurdon, Ark., to Camden, a distance of 35miles. Of course these roads afford facilities for trade and travel to a very limited extent of country above and below their crossings. Even at those crossings the stage of the river has a marked influence on their freight tariff as illustrated at Monroe, where the railroad rate on cotton to New Orleans is 100 per cent. higher during low water than while the boats can run. In other words, railroad freight rates bear an inverse ratio to the gauge reading, showing that not only are river rates lowered by improvement to navigation, but all freight rates to and from the country traversed by the river. Furthermore, the producer paying less freight, the steamer less insurance, the insurance company fewer losses, the consumer, having the benefit of a better supplied market at lower cost, is benefited though he never heard of the river.

EXAMINATIONS AND SURVEYS.

A survey of the Ouachita, from Arkadelphia to its mouth, was made in 1871 by Lieut. Col. W. F. Raynolds, and a resurvey was made by Major Benyaurd, in 1873, of that part from Camden to the mouth. Further examinations were made by Major Miller in 1882 and 1883 and by you in 1886 and 1887. (Reports of Chief of Engineers 1871, page 340; 1872, page 367; 1874, page 352; 1884, pages 1351 and 1386; 1887, pages 1487 and 1495.)

PHYSICAL FEATURES.

The Ouachita is a river with very little slope, the average fall, during the low water from Arkadelphia to the mouth being 0.25 feet per mile. The fall varies over different sections of the river as shown by the following table of distances, fall, etc., at low water.

Points.	Distance.	Fall per mile.	Shoals.	Combined length of shoals.	Average depth of shoals.
	Miles.	*Feet.*	*Number.*	*Feet.*	*Feet.*
Arkadelphia to mouth of Little Missouri River	42	0.38	15	7,700	1.45
Mouth of the Little Missouri River to Camden	32	0.35	8	3,800	1.81
Camden to Eldorado	44	0.40	17	24,500	1.37
Eldorado to Jack's Island	32	0.28	6	32,600	0.93
Jack's Island to Ouachita City	64	0.14	14	51,000	1.25
Ouachita City to Monroe	27	0.37	9	37,700	1.50
Monroe to Columbia	59	0.25	17	37,900	2.10
Columbia to Trinity	68	0.10	2	8,400	2.10
Total	370	0.25	88	213,600	1.54

NOTE.—The data given from Arkadelphia to Camden were taken from the first survey, which was not as minute as the second survey, from which the rest were obtained. Not only does the average fall vary for different sections, but it also varies in any one section, the river being a succession of pools and shoals, the fall on the shoals being at the rate of 17 feet to the mile in some instances; the pools increase in length and depth, and the shoals decrease in number and become deeper the nearer the mouth. Above the mouth of Little Missouri River the discharge at low water is very small, and at Camden is only 353 cubic feet per second; at Monroe it is about 800 cubic feet per second, and at Catahoula Shoals 1,056 cubic feet per second. The water in time of flood bears very little sediment, and is comparatively clear, except when discolored by the Mississippi. The oscillation at Camden is 39.25 feet, and at Trinity 53.4 feet, the increase in oscillation at the latter place being largely due to overflow from the Mississippi River. In their report on the Mississippi River, Generals Humphreys and Abbot quote from Darby: "Few rivers differ more in quantity of water at different seasons than the Ouachita; flowing from a hilly or mountainous tract, more constancy might be expected in the volume of water, but though the places drained by the Little Missouri River, and Fouche and Caddo are not deficient in springs, yet the extensive region toward the sources of the Ouachita has little water except what is supplied by rains in winter and spring; when the parching heat of summer has dried the country above the mouth of Little Missouri the Ouachita becomes very low." The bed of the river is generally composed of sand and gravel on the shoals and mud in the pools, though some of the shoals are rocky. The banks are generally of clay, and do not cave except over a short reach about 25 miles below Monroe. The banks on the upper river are low, though the high lands strike the river at a few points. Below Ouachita City the banks are high and above overflow. The timber growing on the banks is the greatest danger to navigation; in times of flood the leaning trees, and at low stages the snags which have floated down and lodged, being a constant menace to passing water-craft. The river is usually at its lowest stage in August and September, and its highest in January and February.

PLANS FOR IMPROVEMENT.

Plans have been submitted for the improvement of the river by means of locks and dams, and condemned on account of the cost. Snag-boats and clearing parties have worked on the river and removed numerous dangerous obstructions. Work of this character will continue to be necessary no matter what plan of improvement is adopted, as each high water brings down drift. At first thought the simplest plan would seem to be to dredge a channel through the bars, or build contracting dikes. With 353 cubic feet discharge at Camden at low water, the average fall per mile would permit a channel 4 feet deep and 270 feet wide if the fall were regular, but being concentrated on the shoals till it is 1 in 200, the width there could only be 24 feet.

The result is obtained from the equation given by Weisbach, $m\ i = \epsilon\ v^2$, where $\epsilon = .00012$ in slow currents, and $Q = v\ A$. As the result is not considered to be absolutely exact, the difference between this and Kutter's or other formulas need not be considered. Since the fall was concentrated by nature and there is no practical way to redistribute it, it is impossible to obtain the theoretical channel 270 feet wide and 4 feet deep, and on the steepest shoals the channel can only be 24 feet wide if 4 feet deep.

Below Monroe, where the discharge is about 800 cubic feet per second on the steepest shoals, a channel 54 feet wide and 4 feet deep is possible, the least, mean and greatest velocity being 2.85, 3.80, 4.75 feet per second or about 3¼ miles an hour. The bottom velocity 2.85 would move gravel about 1½ inches in diameter and would probably scour out the bed. The objection to confining the river by dikes so as to make it do the work of scouring is, if it scours too much it admits too great flow in the diked channel and drains the pool above the shoal, virtually bringing to the top new obstructions. Since deepening the shoals lowers the pools, and lowering the pools lowers the high water, building dikes will, if continued, prevent overflow. By close attention and large expenditure it is possible to remedy local trouble by making dikes cause scour, but in general the benefit is too limited, the cost too great and the result too uncertain to justify the experiment. By building lateral dikes with longitudinal wings below a shoal and carrying a sill or pavement all the way across the bottom of the opening which is to be left the proper size, the water can be backed up over the shoal and all the fall concentrated at the dikes. Dredge the shoals and the dikes will form dams with incline openings for the passage of boats. To improve the river in this way, supposing the fall on each shoal would admit of concentration at one dike at each shoal below Monroe, it would require 19 dikes and about 124,000 cubic yards of dredging, nearly 4,000 cubic yards of that being solid rock.

At some place above Monroe, probably about Ouachita City, there is not water enough to provide open low-water navigation. Any project should contemplate the

ultimate improvement of the whole river, and the dikes and dredging could be only successful over a part, under the most favorable circumstances. I can do no better than quote from Colonel Merrill's translation of the Memoir of S. Janicki, Engineer, director of the Maskva Navigation Company: "For rivers of minimum average discharge, locks and dams must have the preference over every other system." "Canalization is the *only means, sure and free from errors,* to employ for improving the navigability of rivers."

The estimate of Major Benyaurd in the Chief of Engineer's Report for 1874 indicates the cost of such plans:

For seven locks, 70 feet wide, 300 feet long, 10 feet lift, and allowing all boats to go to Camden—

Masonry	$4,952,976
Timber	2,644,768

By reducing the lift to 7 feet the number of locks is increased to ten and the cost to—

Masonry	$6,079,233
Timber	2,995,566

The plan modified so as to build seven small locks with 10 feet lift and moveable dams would allow the largest boats to run during high water and yet not overflow the country. In the report on "Movable Dams on Upper Seine," the following appears:

"Careful observations on the river before and after the construction of the dams showed they produced no sensible effect on the height of floods. When they are submerged, a very slight ripple on the surface is all that can indicate their presence. The works themselves were not injured, especially if the lock-gates were opened before the arrival of the flood. The only effect was a slight deposit of sediment in the locks."

By dredging at Catahoula Shoals and Bayou Louis Shoals, two locks of this character, one a mile above Columbia and one at the foot of Taylor's Shoals, would give 4 feet as the least depth all the year as high as Rock Row Shoals, 18 miles above Monroe. A single lock, with a lift of 14 feet at the first shoal above Columbia, 18 miles, with the dredging at Catahoula and Bayou Louis shoals, would accomplish the same end. While the building of only one lock would decrease the cost, the greater lift, besides being a disadvantage in locking, would necessitate the building of the most expensive form of movable dam. The cost of material and labor has decreased since the plan for locks and dams was first submitted, and that estimate may now be taken as an approximate estimate of the cost of movable dams. Without detail surveys of the lock-site no accurate estimate can be made, and yet detail surveys should not be made unless there is a prospect of work beginning, since their object is to develop conditions, and they are constantly changing.

Unless the improvement of the Ouachita is to serve as a key, it would be useless until the navigability of the mouth of Red River is accomplished.

Estimate of cost.

By dikes and dredging channe' 50 feet wide, and 4 feet over the shoals, from the mouth to Monroe—

Dredging 120,000 cubic yards, at 35 cents	$42,000
Dredging 4,000 cubic yards, at $3.50	14,000
19 rubble dikes, 57,000 cubic yards, at $1	57,000
Paving between wings	15,000
	128,000

Locks and dams.

Two locks 50 by 250 feet, 10 feet lift, and movable dams giving 4 feet least depth to Monroe by dredging and diking Catahoula and Bayou Louis shoals—

Dredging 15,500 cubic yards, at 35 cents	$5,425
2 dikes, 6,000 cubic yards, at $1	6,000
2 locks and dams	584,800
	596,225

One lock and dam, 14 feet lift—

Dredging and dikes	11,425
Lock and dam	376,250
	387,675

When I examined the river in March, 1887, the pilot was unwilling to take the snag-boat above Camden, the gauge reading 18 feet above low water and the river falling, because he feared that the boat, though drawing only 26 inches, might be caught above the shoals. He states under recent date that he can not give reliable information of the river above Camden, because none of the Ouachita pilots are familiar with that portion of the river. The regular New Orleans and Camden boats make occasional trips above, say 15 to 40 miles, after staves, and the captain of the boat employs a stave-man to point out the way to the pilot, the river being full of tow-heads and gravel-bars. Assistant Engineer Davis, now in service on Bayous Maçon and Tensas, states that the upper section of Ouachita is used for navigation only when a stave-boat is to be towed out, and that it is not a frequent occurrence.

The master of the snag-boat *Hooker*, a light-draught steam-boat, recently bought for service in Ouachita and tributaries, states that the rises and falls in the upper river are quite rapid, sometimes as much as 15 feet in 24 hours, and that, in his opinion, the only way to improve the river is by chopping parties working from flat-boats.

The wharf-boat agent at Camden stated that Camden was considered the head of navigation and was the principal shipping point for cotton, the business of the upper river consisting chiefly in lumber and staves. Assistant Engineer Coppée found the river in about the same condition as reported by Major Miller.

The obstructions consisted of shoals, crooked rapids over rocky ledges or compacted gravel, logs, snags, and leaning timber. To make this part of the river navigable for larger boats at a 5-foot stage would require a system of locks and dams and the removal of all leaning timber, snags, etc., but this would require the same system to be continued to Red River.

The estimates given by Assistant Engineer Marshall are for work that must be considered either as experimental, as regards dredging and longitudinal dikes, or as only a beginning of a system for slackwater navigation. If it should be thought advisable to try the former the experiment could be made on a moderate scale, using plant now in service in the district, with some additions, and selecting the worst shoals below Monroe for the trial, and for this purpose only local surveys would be required. This work could be carried on under the present project, if an appropriation should be made large enough to allow the usual snag-boat service to be continued, say $25,000 for general operations, and $15,000 for dredging and wing-dams. If, however, the slackwater system should meet with approval, then it should not be commenced until after detailed surveys and estimates for systematic improvement from Arkadelphia to Red River, and this would cost at least $200 the mile, or nearly $100,000, the river being approximately 470 miles long. Such a survey would have to be most complete, not only to furnish a basis for estimate for the work, but to determine the probable overflows and consequent damages to lands in the valley. It is very difficult, in fact it is almost impossible, to get trustworthy reports of the commerce of Ouachita River and its tributaries. I have sent out circulars yearly to steam-boat men and others interested in commerce and navigation in this district, but have had very meager returns.

There is no system of accounts kept by river men from which estimates of the business done can be made. "There are no records whatever of the shipments made away from New Orleans by river; the only things to go by are the trip-books of the steamers and barge lines, and

as some of these have been lost or destroyed, it is impossible to obtain full and complete accounts of the exports from the city by river." (Internal Commerce of the U. S., 1887, page 158.) The same remarks will apply to down-stream freight.

It is probable, however, that ten millions of dollars is not too large an estimate for the commerce of the Ouachita River and tributaries, but the business does not seem to be increasing, if the values heretofore reported can be accepted. At any rate, the amount of commerce to be benefited is not of sufficient value, and can not be expected to increase sufficiently for many years, to justify the inauguration of an expensive system of permanent improvement.

Ouachita River and its principal tributaries are worthy of improvement, and such work of public necessity, but operations should be carried on as heretofore under the adopted projects. The plant now in service in the district is fairly complete and not expensive, and the cost of keeping these streams in a good navigable condition, suited to the needs of commerce, should not be great.

In my opinion all that is required is the regular appropriation of the small amounts reported annually by the engineer in charge.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX X.

IMPROVEMENT OF ARKANSAS RIVER; OF RIVERS IN THE STATE OF ARKANSAS; OF BLACK, ST. FRANCIS, AND LITTLE RIVERS, ARKANSAS AND MISSOURI.

REPORT OF CAPTAIN H. S. TABER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Red River above Fulton, Arkansas.
2. Little Red River, Arkansas.
3. Removing obstructions in Arkansas River, Arkansas.
4. Arkansas River, Arkansas.
5. Petit Jean River, Arkansas.
6. Fourche River, Arkansas.
7. White River, Arkansas.
8. Cache River, Arkansas.
9. Black River, Arkansas and Missouri.
10. Black River, Missouri.
11. St. Francis River, Arkansas.
12. St. Francis River, Missouri.
13. Little River, Missouri and Arkansas.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., July 1, 1889.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1889, upon the works under my charge.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

XI.

IMPROVEMENT OF RED RIVER ABOVE FULTON, ARKANSAS.

On November 12, 1884, a report was made from this office recommending that $10,000 be appropriated for work upon this reach of river. The act approved August 5, 1886, appropriated $7,000, of which $4,000 was to be used to build a hand-propelled snag-boat. The fiscal year ending June 30, 1887, was occupied in building a stanch boat, drawing 15 inches of water, with machinery capable of lifting snags weighing

75 tons, the low-water season, the only economical time for working, having passed before this was completed. During the low-water season of the fiscal year ending June 30, 1888, the above boat was sent out into the field, and succeeded in removing in two months 798 dangerous low-water channel snags, destroyed 10 piles of drift-wood, and cut a number of overhanging trees.

The act which became a law August 11, 1888, appropriated $3,000 for the completion of the improvement. During the fiscal year ending June 30, 1889, $3,077.30 were expended in the running expenses, repairs to and care of the U. S. snag-boat *Harry Breck*, in removing snags from Fulton to a point 175 miles above, or to within 75 miles of the Kimishi River, the point to which the original estimate proposed to complete the improvement. The snag-boat worked about 3 miles per day; from this it will be seen that it would have required about twenty-five more working days to have completed the original project.

Between the two appropriations the snag-boat had to be cared for about twelve months at about a cost of $900. The average cost of running this boat one month is less than $800; from all of which it will appear that had all of the $10,000 been appropriated at one time the entire improvement would have been completed, with about $100 to spare.

During the fiscal year ending June 30, 1889, the boat was only worked when the water was so low that this boat, drawing only about 16 inches of water, could just get over the bars. The sub-foreman was an experienced pilot on the river, and the snags taken out were taken out from the low-water channel; 764 snags not less than 1 foot in circumference at the top were removed, and a good channel cut through fifteen extensive collections of stumps, logs, snags, tree-tops, locally known as "rack heaps." This has resulted in so much relief to navigation that an unusually heavy traffic has followed. The other 75 miles of river should be opened out, and as a few snags lodge here and there annually over the entire reach, the interests of a growing commerce demand that $2,000 be appropriated for the fiscal year ending June 30, 1891, $1,000 to complete the improvement to the Kimishi River, $1,000 to patrol the entire reach for one month at extreme low water to remove snags that have accumulated (accidentally) during the time since the last improvements were made.

So far as the development of the latent resources of the country go, I know of no more deserving reach of river, in proportion to the cost of giving it relief, than this one. Attention is especially directed to the facts submitted with reference to commerce.

COMMERCE.

The amount of commerce when the present appropriation was made was 20,000 bales of cotton and 2,500 tons of merchandise.

The advantages to commerce if the work is completed will be very great, this stream, like many others, being the only outlet in many instances. The records of this office show that the country is being settled, and that the products are increasing annually.

As to benefits to community if completed, there will be a series of comparatively isolated communities that will receive great benefit from this work, if completed. They are almost wholly dependent upon the river for transportation. The benefits likely to accrue would amount, if represented in money, to many times the total cost of improvement and preservation.

Money statement.

July 1, 1888, amount available	$88.50
Amount appropriated by act of August 11, 1888	3,000.00
	3,088.50
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	3,077.30
July 1, 1889, balance available	11.20
Amount (estimated) required for completion of existing project, annually	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT IMPROVING RED RIVER ABOVE FULTON, ARKANSAS, DURING THE FISCAL YEAR ENDING JUNE 30, 1889.

Pay-roll, labor, etc	$1,827.12
Subsistence supplies	341.58
General supplies	631.11
Transportation	10.35
Fuel	87.00
Traveling expenses	75.02
Rent	80.00
Telegraph service	.62
Stationery supplies	24.50
Total	3,077.30

X 2.

IMPROVEMENT OF LITTLE RED RIVER, ARKANSAS.

The first improvements attempted upon this river were made in the year ending June 30, 1872, under the act approved March 3, 1871. Prior to this work many overhanging trees and a large number of snags interfered with navigation in the lower reaches, and many bowlders obstructed flat-boats and raft navigation in the reach above the present town of Judsonia. The appropriation, referred to above, was for the White, Black, and Little Red Rivers, and amounted to $10,000 for the three, upon estimates amounting to $259,033, of which $38,065 were for the Little Red River. That little work could be done is apparent from Colonel Reynold's report for 1872, in which he states: "Unless other and better facilities are provided, it will be of very little use to attempt to remove the obstructions in such streams as these." Most of the overhanging trees were removed as high as Judsonia. A bad shoal 3 miles below Judsonia and the bowlders remained untouched to the end of June, 1886. The act approved August 5, 1886, appropriated $3,000.

The present project contemplates the removal of the dangerous bowlders above Judsonia and a shoal 3 miles below the same town. Up to June 30, 1888, $612.90 had been expended in removing the bowlders above Judsonia and the care of the property and records. By the act which became a law August 11, 1888, the balance, $5,400, necessary to carry out the original project, was appropriated.

During the fiscal year ending June 30, 1889, $5,008.90 was expended in the construction of the dredge to be used in removing the shoals 3 miles below Judsonia, and in the construction of two material barges.

Effective work under this head can only be done at low water, and as this does not occur until in July or August each year, no progress could be made during the fiscal year. As early in the next fiscal year as may be, work will be begun and pushed to completion. It is believed that the present appropriation will be adequate for this purpose.

A very strong dredge-boat specially adapted to the work has been built and thoroughly tested. Prompt opening of the channel may be expected.

COMMERCE.

Amount of commerce when work of improvement began may be inferred from the following, which appeared in the Annual Report of the Chief of Engineers, 1871, page 362:

> The fact stated, that the commerce of this stream is sufficient to induce the comparatively large boats running on the White River to navigate it whenever it is practicable, and when this is not the case that a small steamer is kept to ply between West Point and the mouth of the river, shows the importance of the interests involved.

As to prospective advantages to commerce if completed, if the shoals known as Bess Shoals were removed, so that a boat could reach Judsonia at all stages of the river, from 1,000 to 1,500 bales of cotton and about 400 tons of merchandise would be shipped by river at once.

A packet drawing 3½ feet of water now makes regular trips the year round to a point just below these shoals.

The country round about Judsonia has been visited in person, and I find its resources have only begun to be developed. I should say that the present commerce would double itself in five years.

As to benefits to community if completed, it is hard to estimate the benefits that cheap transportation would give to a community that has known only a railroad outlet, and only one at that. No one will question but what they will be very great; how great can be told only by recalling what such transportation has done for other fertile sections; but it may be safely said that the benefits will be so great that the outlay will sink into utter insignificance.

This stream is located in a very prosperous section of the State. The present commerce amounts to upwards of 13,500 bales of cotton and 4,700 tons of merchandise. A great deal of fruit is being raised and the amount is increasing rapidly each year. The returns will be immediate.

Money statement.

July 1, 1888, amount available		$2,387.10
Amount appropriated by act of August 11, 1888		5,400.00
		7,787.10
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$5,682.71	
July 1, 1889, outstanding liabilities	35.00	
		5,717.71
July 1, 1889, balance available		2,069.39

EXPENSE ACCOUNT.—IMPROVING LITTLE RED RIVER, ARKANSAS, DURING FISCAL YEAR ENDING JUNE 30, 1889.

Pay-roll, labor, etc	$1,317.33
General supplies	4,280.53
Transportation	40.90
Traveling expenses	35.23
Telegraph service	3.72
Fuel	5.00
Total	5,682.71

X 3.

REMOVING OBSTRUCTIONS IN ARKANSAS RIVER, ARKANSAS.

As the first expenditure of money on this river was made as early as 1833, it is not an easy matter to determine what was the original condition of the navigable portion of this stream, but from the delta-like character of its lower portion, and the tendencies now manifest in its upper reaches, it may be inferred, upon very substantial grounds, that shifting sand-bars, numerous drift-piles, and dangerous snags characterized the obstacles to navigation in the lower reaches, and gravel and rock shoals, with a few snags and many overhanging trees, constituted those of the upper reaches. The records of this office indicate that except at a few places, such as Pine Bluff, Ark., and Fort Smith, the general plan of improvement has consisted of snagging operations, which includes cutting overhanging trees and in building wing-dams to improve the shoals, the idea being to afford temporary relief to navgation until complete surveys should render it possible to project a plan for the radical and permanent improvement of the navigable portion of the entire river.

For the exceptions noted, attention is respectfully invited to reports upon those special cases. The appropriations have been made sometimes for the entire navigable reach and sometimes for certain sections.

The grand total of all these appropriations up to June 30, 1888, amounted to $440,251.87. Of this there had been expended to June 30, 1888, $367,477.89, exclusive of certain sums, aggregating over $100,000, that were appropriated with the Mississippi and Missouri rivers so as not readily to be determined.

The most permanent result of all this expenditure consists in a series of maps made by S. T. Abert from a survey of the river from Fort Gibson, Ind. T., to Big Rock, Arkansas, 3 miles above Little Rock, Ark., in the year 1870. From the nature of the case the balance of the work has been each year a repetition of that of preceding years.

One iron-hulled snag-boat and one light-draught wooden snag-boat, with all the appliances necessary for snagging operations, were the visible signs of the balance, while the gratitude of those interested in the navigation of the river, for a navigation rendered yearly less and less dangerous by the operations of these two boats, is the only evidence existing and the only evidence to be expected of work that must be done in a stream like this, until by some system of permanent improvement caving banks no longer exist and the annual quota of snags is no longer furnished.

The most economical management of snag-boats requires not less than $35,000 annually to give absolutely indispensable aid to navigation; a navigation in which a vast amount of commerce is vitally interested.

By act approved August 11, 1888, $25,000 were appropriated for this reach; $10,000, or so much as might be necessary for building a new hull for the snag-boat *Wichita*, including capstans and the transfer of the upper works, and $375 for completing the survey and maps, the balance to be expended for removing obstructions. As this total amount was very small compared with what was absolutely indispensable, it seemed to be of the utmost importance to operate a snag-boat upon a lower stage of water than that suitable for the lightest draught packet. Having no such snag-boat, steps were immediately taken under this appropriation to build a new hull for the *Wichita*, and so proportion it as to make it of lighter draught than any on the river. This could not be done in season for operations during the low-water season of the fiscal year ending June 30, 1889; therefore, the fiscal year ending June 30, 1889, has been devoted principally to the remodeling of the hull of the *Wichita*, and this being completed, waiting for low water. It may be important to state that the reconstructed *Wichita*, at a cost of less than $9,000, draws but 12 inches of water, is 135 feet long by 30 feet beam, has sixteen water-tight compartments in its hold, all of which are provided with suitable syphons, arranged for rapidly pumping the water in case of boats being snagged, with two fine Providence steam capstans with reversing-engines, capable of lifting some 65 to 70 tons through the shears. Her enormous power and light draught will, if she is operated at the right stage of water, namely, extreme low water, make her a very effective boat. The completion of the construction so much within the estimate was due in part to the abundance of labor and the favorableness of the season, but principally to the skill and economy practiced by Capt. W. J. Ashford, who, from his long experience in this district in snagging operations, was able to combine in this boat all the excellencies of the old boats and eradicate their defects, adding also such features as experience has shown to be desirable.

During the fiscal year ending June 30, 1889, $13,090.79 were expended as above and in the care of the property and records. The completion of the survey and maps has been postponed until a draughtsman can be obtained at such a rate of pay as will insure the completion of the work within the amount allotted.

Early in the next fiscal year the low-water season will set in, and the snag-boat *Wichita* will be vigorously operated from Webber's Falls to the mouth of the river. Webber's Falls are 40 miles below Fort Gibson. I have been over this entire reach of river within the past six months, and know that the balance available will only suffice to remove the worst snags. The interests of navigation demand an expenditure of at least $70,000 during the fiscal year ending June 30, 1891, and the immediate construction, in addition to this, of an entirely new snag-boat, modeled after the *Wichita*, at a cost of not to exceed $20,000, in order that there may be two light-draught snag-boats of great power to operate during the short season of extreme low water. There is now in my possession belonging to this appropriation one heavy steel-hull snag-boat, which cost something over $112,000, and which draws 3 feet of water. She is a very efficient boat for such a river as the Missouri, but is of too great draught to do effective and economical work in the Arkansas River any longer, as she has already removed all the obstructions that interfere with navigation that she can reach, leaving the most dangerous obstructions untouched.

I would respectfully recommend that the boat be sold to some appropriation where she might be an effective and serviceable boat, and the proceeds of the sale be devoted to "Removing obstructions in the Ar-

kansas River, Arkansas and Kansas." She is probably worth from $60,000 to $70,000.

By this arrangement it might be possible to meet the requirements of the fiscal year ending June 30, 1891, by appropriating $25,000; $20,000 for a new snag-boat, modeled after the new *Wichita*, and $5,000 contingent fund, in event of the heavy snag-boat not bringing over $65,000 at her sale.

COMMERCE.

As stated in this report, this work was begun in 1833, and there are no records available in this office to show what commerce, if any, passed over this river.

In 1852 a gentleman in Little Rock lost five out of six of the steamboats owned and run by him in one season, due to snags. Navigation must have been uncertain in 1833 and commerce light.

It is estimated that insurance and freight rates have been reduced one-third by the improvement already effected. As to effect upon rates of competing routes of transportation, there are many points where there is no competition. Where there are, cotton is carried at 25 to 50 cents per bale cheaper by water than by rail, and other merchandise accordingly. This must keep railroad rates down.

As to prospective advantages to commerce, if completed, observation shows that whenever the snag-boats, by thorough work, get the channel reasonably well cleared the boats run night and day, eagerly taking advantage of the brief interval before appropriations fail, and the annual crop of snags can not therefore be removed.

As to benefits to community if completed, nothing better can be furnished under this head than a few extracts from a letter from the Little Rock Board of Trade of date April 26, 1889, as follows, viz:

LITTLE ROCK BOARD OF TRADE,
Little Rock, Ark., April 26, 1889.

DEAR SIR: Replying to your favor of April 22, would say your communication has been before our committee on statistics, and I herewith hand you report of river business for this city for the year 1888, showing the total of $2,188,850 as compared with $1,938,000 for the preceding year.

This increase, of course, is due in a great extent to the improvement of the river.

In this connection I desire to call your attention to the hewn-timber business on the lower Arkansas River. Before you commenced your work on the river we had no business of this character. At present it is in successful operation, and with the improvement of the river will necessarily grow very rapidly. A recent shipment from Tiller, to be floated to New Orleans, consisted of 120,000 feet of hewn timber, or 1,440,000 feet, board measure.

* * * * * * *

At present the coal business of Arkansas, with its vast area of coal land, is practically in an undeveloped state, for the reason that the coal can not be handled by river. For instance, the heavy competition by river from the coal mines, reached by the Ohio River, to New Orleans, with the coal mines of Arkansas, shuts us out from the markets of the South. Because of high railway rates the nearer coal is debarred from that market. The difference in price in carriage of the Ohio coal by boat to New Orleans and the Arkansas coal by rail to the same place is at present about three to one in favor of the Ohio River. As a matter of course, with the improvement of the upper river, this condition of affairs will be changed in our favor. Above Little Rock there are thousands of square miles of coal fields in the Arkansas Valley, the development of which business will be of the greatest value.

It is estimated that the Arkansas coal fields contain from three to six million tons of coal to the square mile.

The granite fields of Little Rock find a market, judging from present orders, for about 120,000 tons per annum. This, with river transportation, will, of course, be doubled.

The approximate tonnage received by river into Little Rock from the Arkansas River by boats from the South—cotton, cotton-seed, and miscellaneous freight (raw material), 5,000 tons, valued by river men at $100,000.

Approximate tonnage received by river into Little Rock from the North by boats—cotton, cotton-seed, and miscellaneous freight (raw material), 10,000 tons, valued by river men at $400,000.

Logs, rafted by river for Little Rock, about 5,000,000 feet for lumber, shingles, staves, etc.

Shingles received by river 7,000,000 to 8,000,000.

Lumber (hewn), 100,000 cubic feet for transshipment to European markets.

Yours truly,

GEORGE R. BROWN,
Secretary.

Approved:
M. G. HALL,
C. F. MARTIN,
C. T. WALKER,
W. H. WRIGHT,
Committee on Information and Statistics.
Capt. H. S. TABER,
Corps of Engineers, U. S. A.

To give the advantages to commerce, if completed fully, would be to enter upon the commerce of a great State, and would require an amount of time for compilation and record that would be entirely out of the question. It is forecasting the future of the State's metropolis and railroad center. All that prevents two-thirds of the freight now sent and received at Little Rock from being handled by the river is the fact that there are months of great uncertainty, and the time lost by the boats exhausts the profits.

The rapid increase in prosperity of this State during the five years spent at this office reminds me more of the frontier growth of the West than of the growth of a State, the age of this one. A just conception can only be formed by looking at some great fertile river valley in the Northern or Eastern States, as they were years ago and as they are now since settled up with its river improved.

What benefits have accrued to that community will surely accrue to this with this addition—that the mineral resources of this valley are to be added. Its coal products alone and its wealth of timber will place it well to the fore. When the vast acreage of the Indian Territory is brought under cultivation, its products must go this way.

That well-known and exceedingly fertile State of Kansas will find Fort Smith or Little Rock its nearest water outlet eventually.

It will be seen how difficult it is to handle this question briefly, if it is borne in mind that with deep water to New Orleans from the Gulf, the Mississippi improved, and the Arkansas River navigable to Little Rock by boats drawing 5 feet of water, we have the conditions likely to exist when the improvement is completed.

I have, therefore, only attempted to outline this matter, and trust that, when this portion of the report is read, a map of the territory covered may be had in mind, as this will probably be of itself the strongest proof that the benefits likely to accrue can but be too vast to be summarized in a report like this.

Money statement.

July 1, 1888, amount available		$248.67
Amount appropriated by act of August 11, 1888		25,000.00
		25,248.67
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$12,853.79	
July 1, 1889, outstanding liabilities	237.00	
		13,090.79
July 1, 1889, balance available		12,157.88

Amount (estimated) required for completion of existing project, annually	$35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	90,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT REMOVING OBSTRUCTIONS IN ARKANSAS RIVER, ARKANSAS DURING FISCAL YEAR ENDING JUNE 30, 1889.

Pay-roll, labor, etc	$8,069.29
General supplies	3,086.00
Transportation	16.50
Fuel	65.40
Rent of office	80.00
Telegraph service	.78
Traveling expenses	55.20
Stationery	43.42
Capstans	1,437.20
Total	12,853.79

X 4.

IMPROVEMENT OF ARKANSAS RIVER, ARKANSAS.

Work during the past season has been carried on under two acts of Congress. By act approved August 5, 1886, $75,000 was appropriated under this head, its distribution being indicated in the following words and figures:

Improving the Arkansas River, Arkansas: Continuing improvement, according to the plans and recommendations in Appendix V 13, Executive Document No. 1, 49th Congress, of which there are to be expended $8,000 at Pine Bluff, $13,000 at Fort Smith, and $10,000 at Dardanelle, or so much thereof under these sums, respectively, as may be necessary at these points.

The approved project for the expenditure of these sums may be summarized as follows:

At Pine Bluff the $8,000 is to be used in extending and repairing the dikes; a portion of it to be held as a contingent to watch the action of the river; the idea being to cause the river to become less and less dangerous to the town front.

At Fort Smith the $13,000 to be expended in erecting a permeable dike a little above the town and upon the opposite side of the river, so as to contract the channel and prevent it from leaving the city wharves.

At Dardanelle the $10,000 is to be expended in erecting a permeable dike above and opposite the town, in such position as to remove the sand-bar now in front of the wharves.

From Little Rock to the mouth, the balance, and so much as may not be required at the three places above specified, to be expended in the erection of permeable dikes at the worst places, looking towards the permanent improvement of the river, to give an all-year-round depth of water of at least 5 feet at extreme low water; these dikes to serve as contraction works, but in no instance is violent contraction to be attempted. All the dikes referred to in these projects to be about 12 feet in height above mean low water.

By act which became a law August 11, 1888, $150,000 were appro-

priated under this head, its distribution being indicated in the following words and figures:

Improving Arkansas River, Arkansas: Continuing improvement, one hundred and fifty thousand dollars: *Provided*, That nothing herein contained shall authorize the Secretary of War to enter upon project of improvement of said river as set forth in the report of the Board of Engineers on improvement of Arkansas River from Wichita, Kans., to its mouth, dated New York City, March 16, 1888, and contained in House Executive Document No. 234, 50th Congress, 1st session: *Provided*, That the Secretary of War shall expend the appropriation under this head with reference to the final improvement of this river as contemplated in the Report of the Chief of Engineers for the year ending July 1, 1885, and as authorized in the act for the improvement of rivers and harbors, approved August 5, 1886, and in House Executive Document No. 90, 49th Congress, 1st session; said methods to be applied as the Secretary of War may direct at such points between Wichita, Kans., and the navigable mouth of the Arkansas River, at its junction with the Mississippi River, as he may deem for the best interests of commerce. And all moneys now to the credit of different sections of the Arkansas River, other than the appropriations for the operating of the snag-boats, shall be available for use under this head; and in future the engineer in charge of this work and the Secretary of War shall make report upon the progress and needs of this work under this head, instead of reporting upon disconnected projects, as heretofore. Nothing herein contained shall be understood to prevent the Secretary of War from applying any part or all funds previously appropriated for use at Fort Smith, Dardanelle, in Pine Bluff reach, or from expending not exceeding four thousand dollars to remove the bar in front of Van Buren, or from allotting not exceeding eight thousand dollars as a contingent fund for expenditure in Pine Bluff reach.

The approved project for the expenditure of this sum may likewise be summarized as follows:

At Pine Bluff the same as above.

At Van Buren the $4,000 to be expended in erecting a permeable dike at a suitable point a little above the town and upon the opposite side of the river, to contract the channel and prevent it from leaving the city wharves.

From Fort Gibson, Ind. T., to the mouth of the river, the balance to be expended in the erection of permeable dikes, and in one instance, by rock excavation at the worst places, or the places at which serious interference with the largest amount of commerce occurs, so far as the amount of the appropriation will permit, looking toward the permanent improvement of the river, to give the channel, as provided under the act of August 5, 1886, from Little Rock to the mouth, an all-year-round depth of water of at least 2 feet from Little Rock, Ark., to Fort Gibson, Ind. T.

Under both acts the works to be carried on by hired labor and the purchase of material in open market, as this is believed to be most economical and advantageous to the Government.

Before operations were begun at Fort Smith the old jetty at that place, built in 1877 and 1888, had so far disappeared as to render no service, and the river was about to throw a bar along the wharves of the town.

At Dardanelle a bad bar had formed along the town front, cutting off all approach to either wharf at low water or at medium stage.

At Pine Bluff the condition before improvement may be found by referring to the report, "Improving Arkansas River, Arkansas, Pine Bluff," Annual Report, Chief of Engineers, 1887, page 1515, and were of so grave a nature that a re-enumeration here would occupy too much space.

From Fort Gibson to the mouth of the river the river consists of alternating bars and caving banks, with crossings more or less troublesome at low water, a few of the latter operating to effectually close the river to navigation at extreme low water for even boats drawing but 2 feet of water.

In all cases of this kind the crossings occur at points at which, while the river is falling from a 10-foot stage to extreme low water, its water is so widely spread that it develops no channel at any point. Five years of careful study of this river, combined with the testimony of the navigators of the river, all point to this fact, that the crossings are deep or shallow in proportion as the water is narrow or broad at or above the crossing, and that a very slight contraction, such as that produced by a few logs, tree tops, and sometimes clay lumps, just sufficient to give defining power to the current, will convert a bad crossing into a good one.

During the fiscal year ending June 30, 1889, $6,044.09 have been expended at Pine Bluff in the erection of a new dike and repairs of one of the old ones. During the winter time the point of impact of the current, as it bore down upon the town, was moved, according to plan, farther down the town front and ultimately left Dike No. 2, made heavy to receive it, and bore down upon a light dike known as No. 3. This dike was intended to do sentinel duty until the new point of impact developed. It was severely punished, but held its ground until a new and heavier dike was placed above it, as shown on Sheet "A."

Under the influence of this new dike, which will be known hereafter as New Dike No. 3, the current is now so deflected as not to strike the bank, after leaving the end of the dike, for more than treble the distance that was protected by Dike 2, when it was erected for a similar purpose, in 1884 and 1885. This shows the progress that has been made. The river has assumed a flatter curve and everything favors the ultimate success of the plan. The chances of the cut-off above the town taking place are much less than before. The balance of the contingent is held to watch all these conditions, and it is recommended that at least $8,000 more be made available as a contingent fund. The salvation of the harbor is practically secured, and when the very grave nature of the situation in 1884 is considered, the results so far are most gratifying and so great that the outlay so far is insignificant. It only requires a contingent fund, to use in aiding the river, when necessary, to do its own work, until it is moved so far from the town as to no longer endanger its harbor or itself.

Where the worst caving was taking place in 1884 there is a bar with willows upon it over 20 feet high. The river channel of 1884, above the town, under the influence of Dike No. 1, is now occupied by a bar some 10 or 12 feet above low water and many acres in extent, rapidly growing up to young cottonwood. This represents a fill in some instances of upwards of 80 feet of sand. The new enterprises, started upon the confidence given by the works, have capital rising into the millions.

At Fort Smith, Ark., $26.88 was expended during the fiscal year ending June 30, 1889, in watching the effects of the dike. The year has been prolific in rises and the dike has accomplished its purpose very successfully indeed, having deepened the channel in front of the town to the required depth. It has suffered severely from adverse attacks, due to changes in direction of current in the upper, unimproved river, but its work is done. There are two breaches of about 40 feet each through it, and the balance, $233.66, has been held to see if they would require closing to make the work successful. This will no longer be held; one breach has been practically closed by the drift and the other is of no moment, now the work is done.

Present projects for the improvement of the reach above will render the entire dike of no further use in future, only as a supplementary work to those above. The citizens of Fort Smith are justly gratified

with the outcome of the works, and many encomiums have been received touching the matter.

At Dardanelle, Ark., $2,944.62 were expended in erecting 200 additional feet of dike. The balance, $848.43, held as a contingent. So far the results obtained have been in every way satisfactory. The town banks being soft, it has been necessary to proceed cautiously with the erection of the works, so as not to turn the current with too much force against them.

The maximum effects of the works will not be produced until the bar has formed behind them, or, say, about September, 1890. Up to date the bar it is proposed to remove has been very much reduced in size, and the reduction appears to be at about the proper rate, a little too fast, possibly, judging from present appearance, to give about the correct result in September, 1890.

It has been deemed wiser not to extend the works any farther, but hold the balance, as stated, until time develops the exact situation.

When it is remembered that it sometimes takes two or three years for one of these dikes to exert its maximum influence, it will appear how necessary it is to proceed slowly with the construction where this can be done without increasing the expense. To the uninitiated, who expected this bar to move out inside of twelve months, it may be well to add that had the works been so erected as to have accomplished that, at the end of three years, when this maximum effect would have been reached, the town front would have been largely eroded.

At Van Buren, Ark., $3,432.47 have been expended during the fiscal year ending June 30, 1889, in erecting a permeable spur-dike opposite the town, and a little above it, for the purpose of deepening the channel next to the wharf. This dike was finished in the early part of June, 1889, so it is too soon to expect any results. The word "finished" above refers to so much of it as seems desirable to build at this time.

As the draw-bridge lies between the dike and the wharf, it is necessary to use care not to erect so much of the dike as to throw the channel out of the draw. Hence, a small sum has been reserved to watch results, and extend the dike, if necessary.

What precedes may be regarded as work at special fixed points. As to the general work over the entire river as set forth in the acts, $23,513.95 have been expended during the fiscal year ending June 30, 1889. This has erected one dike above the Baring Cross Bridge at Little Rock and repaired another; and erected two dikes below the Little Rock and Fort Smith Railway Bridge at Little Rock, and accumulated material and prepared plant.

Much difficulty was experienced in getting over the river after August 11, 1888, for the purpose of determining just where the small sum appropriated should be used so as to give the greatest relief, and this greatly delayed the preparation of the projects. However, as no appropriation has yet been made for the fiscal year ending June 30, 1890, this is an advantage rather than otherwise, for there will be greater number of skilled workmen available, as work has to be suspended elsewhere in the district.

Everything is in readiness to vigorously push the work early in the next fiscal year.

The results from this general work have all been most satisfactory wherever the dikes have been erected a sufficient length of time to do the work expected of them.

The work at Eagle Bend and at White Bluff, done in the fiscal year ending June 30, 1888, has, of course, had time to demonstrate its utility,

and is in every way successful. The requisite depth of 2½ feet to 3 feet at extreme low water has been maintained, no bar has formed below, and no caving of the banks opposite the dikes has taken place. Navigators of the river are loud in praise of the work and very enthusiastic over it. The work of the years 1888 and 1889 above the Baring Cross Bridge is probably the most striking in its success. Before any work was done the current had left the draw-span, which is next the south abutment, and was eroding the bank just below the north abutment, forming a bar very rapidly in the draw. So successful have the dikes been that there is now a bar some 10 feet above low water from the north abutment to the first pier, and the current already passes through the north half of the draw-span and will, when the dikes produce their maximum effect, it is believed, return to its normal condition when the bridge was erected.

The blue lines, Sheet 1, map of the Arkansas River, Little Rock to mouth, shows the position of the dikes. The dikes below the Little Rock and Fort Smith Railway Bridge, erected in the year ending June 30, 1888, rendered good service. Those intended to act in conjunction with them, erected in the year ending June 30, 1889, have not had time to develop their usefulness. By December 1, they will have had time to have had some influence, and as they are upon one of the worst places upon the river, a special report could be prepared which might be of practical value as demonstrating the effects of construction works of this kind under a severe test. It was my intention to submit tracings with soundings (taken at the various points where the improvements have been made) during the last few days of June, 1889, but the river has kept up so that the actual depth at low water, which must be had, could not be obtained.

It will be borne in mind that under this plan the river opposite the dikes may shoal up during high water, just as it did before the dike was erected, the dike being low, but when the river falls in a natural state it may define a channel and may not. In its improved state the low dike obliges it to go to the other side and define its channel. Clearly then, to demonstrate the depth of water obtained, no reduced soundings will do, but of necessity one must take the actual depth at low water, when the river, under the influence of the dike, has defined its channel. Since December, 1888, no time has occurred when such soundings could be taken. If these are required, they may be had in September and October, or November, but probably not with certainty earlier than that.

There have been a few days during this time when the water has stood at 5 feet on the gauge, or less, and it has been at times like these that the navigators have observed the increased depth due to the works, which was so satisfactory that they volunteered the information as to the facts out of pure enthusiasm over present and prospective results. Considerable study and management is required to enter upon a work which should have had $450,000 for the first year, with only $150,000. A certain amount of plant is indispensable if economical work is to be done; and yet, if it were all to be built with this small appropriation, it would leave very little money for actual construction work. The Pine Bluff, Fort Smith, and Dardanelle plant has been utilized, and a small additional equipment will be added. If prompt, economical results are expected, at least $450,000 should be made available under this head for the fiscal year ending June 30, 1891, and it will require, according to the present plan, $3,651,479 to complete the improvement.

I would respectfully invite attention to the wonderful development

of this State, and the natural tendency of all this to make Little Rock a great commercial center.

All the statistics connected with my reports bear upon this more or less. As one reach of river under consideration has Little Rock at its head, the great importance of these works becomes more apparent.

A careful study of statistics for four years convinces me that the State of Arkansas will ere long rise many files in the rank of the States, and public improvements will return manifold their cost in material benefit to the entire State.

COMMERCE.

For commerce see report upon "Removing Obstructions in Arkansas River, Arkansas."

Money statement.

July 1, 1888, amount available		$10,009.54
Amount appropriated by act of August 11, 1888		150,000.00
		160,009.54
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$35,935.13	
July 1, 1889, outstanding liabilities	1,778.59	
		37,713.72
July 1, 1889, balance available		122,295.82
Amount (estimated) required for completion of existing project		3,651,479.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		450,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

EXPENSE ACCOUNT—IMPROVING ARKANSAS RIVER, ARKANSAS, DURING FISCAL YEAR ENDING JUNE 30, 1889.

Pay-roll, labor, etc	$18,599.41
Fuel	802.12
Transportation	92.61
Rent	160.00
Telegraph service	16.99
Stationery	101.91
Steam-boat and two barges	3,000.00
Pile-driver	1,100.09
Skiff	23.00
Traveling expenses	385.83
General supplies	9,307.86
Subsistence stores	2,345.38
Total	35,935.13

X 5.

IMPROVEMENT OF PETIT JEAN RIVER, ARKANSAS.

Before improvement this river was obstructed by snags, logs, drift-piles, overhanging trees, and shoals.

The original project for improvement contemplated rendering it navigable during high and medium stages of water as high as Danville, Ark., by cutting the overhanging trees and cutting up the snags, logs, and drift. The fall in the river is so great that nothing could be done to improve the shoals. The first appropriation ever made for the river

was that of the act approved August 5, 1886, amounting to $3,500, one-half the estimate, $7,000. This amount was expended prior to June 30, 1888, in completing the work of improvement to Rocky Crossing, or about half the distance. The act, which became a law August 11, 1888, appropriated $2,500, and provides for continuing the improvement *below* the iron bridge at Rocky Crossing. It will be seen that this is a departure from the original project, and contemplates entering upon an improvement of a semi-permanent character. This reach of river was accordingly visited in person and a new project prepared and duly approved. This project provides that $2,500 be expended below Rocky Crossing in removing timber from the low-water channel, and in removing a small portion of the ledges at Slaty Crossing and Robinson's Ridge, so as to prolong the season of navigation. The best season for conducting this work begins about the middle of August or the 1st of September. The date at which the act became a law precluded the possibility of making the examination, preparing the project and commencing the work during the fiscal year, ending June 30, 1889, as high water would have interrupted the work before it would have been completed, rendering suspension of work necessary, thereby adding materially to the expense of transporting men and material to the works on two different occasions, when one would answer as well. For these reasons no work except that which was necessary to make the examination has been done during the fiscal year ending June 30, 1889. Late in August or early in September the work will be begun in accordance with the approved project. It is scarcely necessary to prolong this report to state the advantages to be derived from the improvement, since these are set forth at length in the remarks in reference to commerce. It is my duty as Engineer officer in charge to renew the recommendations of improving the river from Rocky Crossing to Danville, according to the original project. Three thousand five hundred dollars will be required for this purpose; in this connection attention is respectfully invited to my reports of the last two years. The entire river to Danville will some day be a valuable artery of commerce, and the bridge at Rocky Crossing, which now obstructs its free and safe navigation, should be made to comply with the law at as early a date as possible.

COMMERCE.

When works of improvement began, a boat made two or three trips a year, at high-water or medium stages, and brought out from 200 to 300 bales of cotton. With the improvement completed, freight rates would be reduced 50 per cent. and distance in hauling by wagons reduced 26 miles. There being no competing routes of transportation, except wagons, no comparison of rates can be made. The completion of the works as originally recommended would increase the commerce ten-fold, and it is estimated by one writer that from 5,000 to 6,000 bales of cotton would be moved by river. Another writer estimates the increase at from 50 to 100 per cent. The community generally would receive many benefits. One writer estimates that products could be marketed at one-half present cost; another states as an incidental benefit, that the freeing of the river of obstructions will reduce the overflow, thereby increasing the areas under cultivation and improving the general health of the section. To all this may be added the fact that this stream is the only outlet to the Petit Jean Valley. This valley is very rich. The town of Danville, in this valley, receives over 1,000 tons of freight

annually, by wagons. Timber is plentiful and in great variety. The great draw-back to this section is its want of cheap transportation. The opening of the Petit Jean to navigation for 5 or 6 months would be of untold value to the entire valley.

The limits of a report of this kind forbids entering into details, but it may be stated, in a general way, that the total required to complete the work is insignificant compared with the results to be gained.

Money statement.

Amount appropriated by act of August 11, 1888	$2,500.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	49.48
July 1, 1889, balance available	2,450.52
Amount (estimated) required for completion of existing project	3,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	3,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT: IMPROVING PETIT JEAN RIVER, ARKANSAS, DURING FISCAL YEAR ENDING JUNE 30, 1889.

General supplies	$21.20
Fuel	11.00
Traveling expenses	17.28
Total	49.48

X 6.

IMPROVEMENT OF FOURCHE RIVER, ARKANSAS.

The improvement of this stream was begun in 1879, under the act approved March 3, 1879. Prior to any improvement its channel was choked with snags, logs, and drifts, and heavy timber overhung its banks. Several bad shoals also impeded navigation.

Up to June 30, 1886, $21,000 had been expended in removing the greater part of the obstructions through the shoals, and now and then a snag that has washed in since work was suspended, in December, 1882, still offers serious obstacles to navigation at medium stages of water.

By act approved August 5, 1886, $5,000 were appropriated for removing rock shoals situated about 4 miles below Perryville. At the close of the fiscal year ending June 30, 1888, this sum had been expended, completing a channel about 500 yards long, 30 feet wide, and 2 feet deep at low water through this shoal.

For the past two years recommendations have been made with reference to the improvement of certain shoals below this one, and for snagging operations.

As no appropriation was made by the act which became a law August 11, 1888, no work was done during the fiscal year ending June 30, 1889, and there only remains to renew the recommendations of these two years.

The commerce upon this river is increasing, and the expenditure recommended, *i. e.*, $7,650, is fully warranted. The valley of this river is so fertile that several railroad companies are considering the propriety of entering it.

COMMERCE.

The amount of commerce when work of improvement began may be inferred from the following, which appeared in the Annual Report of the Chief of Engineers, 1879, page 971:

> The valley of the Fourche Le Fevre is one of the most extensive in the State. Large quantities of lumber and cotton are brought out annually, besides grain, furs, tallow, and beeswax. There are also mines of lead, iron, and other metals in the valley which can be profitably worked when the improvement is completed.

As to effect upon rates of insurance and freight, no data to work from. The incomplete state of the works would be against any great change.

As to effect of competing routes of transportation, there are no competing routes. What freight the steam-boats do not succeed in reaching must be hauled long distances in wagons.

As to prospective advantages to commerce if completed, with this river thoroughly improved there would be a great saving of time to shippers. It would reduce the cost of transportation to that extent that new impetus would be given to the settlement of the country and largely increase its products.

As to benefits to community if completed, there are few communities in this State so dependent on a river for transportation as the settlers of this valley. Every step in the improvement will bring direct gains and will be utilized at once. With such improvements as have already been made, over 3,000 bales of cotton are brought out annually and several tons of freight are handled. One steam-boat* works very energetically upon this river, and takes immediate advantage of every improvement so that the people are sure of immediate relief as the channel is improved.

Money statement.

Amount (estimated) required for completion of existing project	$7,650
Amount that can be profitably expended in fiscal year ending June 30, 1891. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	7,650

X 7.

IMPROVEMENT OF WHITE RIVER, ARKANSAS.

Prior to improvement this river was much choked with snags, drift-piles, and logs in its lower portion, and from Batesville up gravel-bars, rocky shoals, channel bowlders, and overhanging trees impeded navigation. The originally adopted project consisted in snagging operations, blasting of ledges and bowlders, and dam building, to remove gravel-bars, or to close chutes from time to time, as appropriation warranted and commerce required. The first separate appropriation for this river was made by act approved July 5, 1884. At the time it

* Just before mailing this report, I learn a new steam-boat is being built at the head of navigation, at Perryville.

was passed the river was in excellent navigable condition for boats drawing not to exceed 3 feet of water from its mouth to Newport, Ark. From Newport to Batesville there were many troublesome snags, and from Batesville to Buffalo Shoals there were numerous bad shoals, rendering navigation very uncertain. From Buffalo Shoals to Forsythe, Mo., there were many fine reaches of river, but the depth of water on Buffalo Shoals and others less dangerous prevented any navigation at ordinary stages of water. This river has been united so often with the St. Francis, and again, once with the Black and St. Francis, and once with the Black and Little Red, that it is impossible to give exactly how much had been expended on the White River to June 30, 1884. After a careful study of House Ex. Doc. No. 64, Forty-eighth Congress, first session, the approximate amount is set down as not under $170,000 and not over $200,000. This estimate should be given a weight, 8 in a scale of 10.

The project for expending the appropriations made by acts approved July 5, 1884, and August 5, 1886, provide for the removal of snags, bowlders, and other obstructions to navigation, building wing-dams to improve shoals, repairs to and care of plant, and survey of the river, as provided for in the acts, with a view to its permanent improvement from Forsythe, Mo., to its mouth. Up to June 30, 1888, $51,359.65 had been expended. This completed the survey, plotted the notes, and published the maps, effectively improved the most dangerous shoals between Buffalo Shoals and Batesville, removed the more dangerous snags from Batesville to it mouth, and left a small balance of $1,652.35. It was not deemed advisable to attempt any further temporary work with this small balance until the action of Congress should be known, as it could be used more effectively with the appropriation for permanent improvement. By the act which became a law August 11, 1888, $25,000 was appropriated.

In my Annual Report for 1888 $58,000 was specified as the sum that could be profitably expended upon the permanent improvement of this river during the fiscal year ending June 30, 1890. The present project is in accord with the plans and estimates submitted in that report, modified with much difficulty in order to adapt the method of work to the small size of the appropriation, and provide for a limited amount of snagging operations, and provide for the completion of the work on the shoals from Buffalo Shoals to Newport, and the erection of as many dikes as possible upon the worst shoals between Newport and the mouth of the river, and (the most difficult element) the construction of the necessary plant to carry forward the work. The original plan and estimate may be found in detail on page 1486 *et seq.*, Annual Report Chief of Engineers, 1888. During the fiscal year ending June 30, 1889, $10,066.12 were expended in the construction and equipment of six barges, a floating pile-driver, repairs to the quarter-boat, care of property, and in snagging operations between Batesville and the mouth. The only way to advantageously expend the small appropropriation was to dispense with steam-power as far as practicable by moving the quarter-boat and operating barges to Buffalo Shoals (the head of the improvements contemplated at present) at a medium stage of water, and leaving them there until the low-water season arrives. The detailed work on the shoals from there to Newport can be carried on without maintaining a tow-boat.

A car famine during the cotton season caused considerable delay in beginning the construction of the barges, so that by the time they were completed it was necessary to move the operating fleet to Buffalo Shoals.

The continuous low-water season does not set in until about July 1, and closes about November 1.

It will be seen that after completing the plant there was no time during the fiscal year to do effective work. The snagging operations were the most thorough the river has ever had, but could not be completed altogether, due to the early commencement of the high-water season, the policy of snagging only at extreme low water being strictly adhered to, as the only economical and advantageous time to do this work. Everything is in excellent condition for beginning actual operations at the commencement of the next fiscal year; that is, so far as the size of the appropriation warrants. It is hoped, in the interests of navigation, that the next appropriation for carrying out the improvement of this river will be at least the full $58,000 that can be profitably expended during one fiscal year.

Great commercial interests due to inexhaustible mineral resources are concentrated upon the immediate improvement of this river. The expense in accord with the present plan is inconsiderable, and the improvements, when completed, will be of a very permanent character. Active preparations are being made to utilize its waters the moment they are in suitable shape. It is now believed that one more $8,000 appropriation for snagging below Batesville will, if expended in the running expenses of and repairs to the snag-boat *Henry Sheldon*—operating at extreme low water—complete all the snagging operations required, except such few snags as may be removed by a boat equipped as a snag-boat, but used principally for towing and transportation on the work of permanent improvement.

Inviting attention to the plans and estimates submitted in 1888, it is my duty to state that the most economical and advantageous method of completing this work would be to make all the balance required available in one season, as this would save all expense of caring for plant and repairing the same during the interval between two or more appropriations.

COMMERCE.

The first appropriations having been made in 1833, the records of this office do not show what was the amount of commerce prior to any attempts at improvement.

In the Annual Report of the Chief of Engineers for 1876, page 627, Colonel Suter, referring to the upper reaches of this river, says: "The country bordering on this portion of White River is almost entirely dependent on water transportation, which, from the difficult character of the navigation, is very uncertain and costly," and even one year later he speaks of much of the commerce being carried on by teams. (Annual Report, Chief of Engineers, 1887, page 501.)

The advantages to commerce if the permanent improvement is effected will be greatest of that to any other river in the State, in proportion to the cost.

This is a natural highway for commerce to an extensive territory and much of this territory has as yet no other outlet except the wagon. In this connection see Annual Report, Chief of Engineers, 1880, page 1313, Annual Report, Chief of Engineers, 1884, page 1401, also Annual Report, Chief of Engineers, 1885, pages 1589 and 1591. Here will be found a steady increase in commerce, keeping pace with the improvements, which speaks for itself and calls for no comment.

As to benefits to community, it may be said that a community that will follow up the work already done as this one has, can but be greatly

benefited. Every improvement made is promptly taken advantage of. The rapid growth in prosperity in this section warrants the belief that the permanent improvement of this river will confer benefits upon this community so great that the cost of the works will seem too small for comparison.

Any one taking the trouble to read the Annual Reports of the Chief of Engineers for the past twelve years will be struck with the uniform testimony of engineers in regard to the future great commerce of this river, a significant fact in itself.

The following letter speaks for itself:

YELLVILLE, ARK., *April* 23, 1889.

SIR: Your favor of April 18 is before me; in reply I will say that I believe *fully* that transportation has increased within the past nine months on this portion of the White River, viz, from Calico Rock, say to "Oakland," this county, fully 100 per cent. by steam power; of course there have been many barge loads of mineral taken out from Lower Buffalo striking the White River below Buffalo Shoals, which I do not consider in computing the increase, but nearly all the cotton raised in Baxter, Marion, a portion of Boone, Taney County, Mo., as well as boat load after boat load of merchandise has been taken out and brought up by means of the river, which has been of *great benefit* to us during the past year, and if assistance could be given at Buffalo Shoals, and from there up as far as Elbow Shoal, it would be of *great benefit* to this section of country, for *transportation* is what we need.

Very respectfully, yours,

D. H. N. DODD.

Capt. H. S. TABER,
Corps of Engineers, U. S. A.

Money statement.

July 1, 1888, amount available		$1,652.35
Amount appropriated by act of August 11, 1888		25,000.00
		26,652.35
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$10,066.12	
July 1, 1889, outstanding liabilities	328.33	
		10,394.45
July 1, 1889, balance available		16,257.90
Amount (estimated) required for completion of existing project		83,815.00
Amount (estimated) required for snagging annually		8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		91,815.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

EXPENSE ACCOUNT IMPROVING WHITE RIVER, ARKANSAS, DURING FISCAL YEAR ENDING JUNE 30, 1889.

Pay-roll, labor, etc	$4,996.66
Subsistence supplies	513.16
General supplies	2,756.66
Transportation	27.35
Photolithographic maps	280.75
Rent of office	80.00
Traveling expenses	169.98
Fuel	139.20
Telegraph service	4.52
Stationery	50.84
Skiffs	47.00
Hoisting engine and boiler	1,000.00
Total	10,066.12

X 8.

IMPROVEMENT OF CACHE RIVER, ARKANSAS.

The appropriation available is the first ever made for this reach of river. Prior to the work done in the fiscal year ending June 30, 1889, its channel was choked with logs and snags, overhanging trees interfered with smoke-stacks, and several shoals interfered with low-water navigation.

The present project proposes the removal of the logs, snags, and overhanging trees from the town of Riverside, Ark., to the mouth of the river. This operation will incidentally improve the shoals, as they are caused in the majority of cases by an accumulation of logs.

Seven thousand dollars was the amount appropriated; $3,000 for the construction of a snag-boat, and $4,000 for its operating expenses, working at or near extreme low water, the boat being constructed of light draught for this purpose.

During the fiscal year ending June 30, 1889, $3,970.06 were expended building the snag-boat *Riverside*, equipping the same, and removing 67 snags and logs, 14 drift piles, and 69 overhanging trees for 3 miles of river, beginning at Riverside, Ark., and working down. The winter season being exceptionally good for out-of-door work, and James A. Murray, overseer, being a very faithful man and economical worker, with other elements, produced a boat, the duplicate, practically, of the successful boats the *A. B. Johnson* and the *Harry Breck*, for about $800 less than the cost of either. As the continuous low-water season did not set in until the middle of June, only a beginning could be made at removing obstructions. The boat is well adapted to its work, and being thoroughly equipped, and, so far, everything being within the estimate, it is confidently expected that the work *required at present* will be completed within the present appropriation. With the commerce increasing annually, and a vast amount of fertile territory unsettled, it would be unwise to say that all the work that ever will be required has been completed. With a very little expense for a few short dams, with locks, the entire reach could be made an excellent canal, with the swamp above Riverside the feeder, the latter needing possibly a slight amount of artificial work to increase its capacity.

COMMERCE.

It is not easy to ascertain the amount of commerce upon this river prior to the making of this, its first, appropriation. Since the building of the railroad the many obstructions in the stream have caused boats to give up the use of it, and it is hard to get any information in regard to it. It could not have been large, for the obstructions are so numerous as to preclude much use of it.

As to the effect upon insurance and freight rates, this can only be known by actual trial, as this is almost a hitherto unknown river so far as any records go.

As to the effect upon competing routes of transportation, there are probably very few sections in which an open river would afford relief to a burdened people under exorbitant rates made by a single line of railroad, as this one will do. As to relative cheapness, there of course can be no question as to water vs. rail transportation.

Reliable parties state that the opening of the river will cause a marked reduction in freight rates.

As to prospective advantages to commerce, there is at present no computing of them. The timber alone warrants the present outlay. The country is very fertile, well adapted to cotton, corn, fruit, and grain, easily cultivated, and only one-fourth settled, and it is as difficult to predict what the prospective advantages to commerce will be as to have taken up, fifty or seventy-five years ago, and predicted the commerce upon some similar streams in the older States, where thousands and even millions of dollars of freight are now transported annually. The river is really almost a natural canal, and it is believed that fifty years from now will see it provided with a few locks and so used as stated in body of report.

Money statement.

Amount appropriated by act of August 11, 1888		$7,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$3,970.06	
July 1, 1889, outstanding liabilities	408.64	
		4,378.70
July 1, 1889, balance available		2,621.30

EXPENSE ACCOUNT IMPROVING CACHE RIVER, ARKANSAS, DURING FISCAL YEAR ENDING JUNE 30, 1889.

Pay-roll, labor, etc	$1,756.78
General supplies	1,655.82
Transportation	119.66
Traveling expenses	86.59
Fuel	2.00
Stationery	29.90
Telegraph service	2.31
Subsistence supplies	317.00
Total	3,970.06

X 9.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

Before any improvements were made upon this river, its channel was choked with logs and snags, and obstructed by overhanging trees, and in many places shoals interfered with its navigation, at low water, by any but very light-draught boats. Its banks caved but little, and except at the shoals, it was characterized by greater depth of water than is found in streams generally in its vicinity, due to its being narrow and its banks firm. The original plan for its improvement contemplated the removal of the obstructions and the improvement of the shoals, the latter by wing-dams. A few sloughs were to be closed up so as to confine the water to the main channel. Up to June 30, 1885, $56,242.40 had been expended in carrying out the above plan. The river, as a whole, gives evidence of persistent effort along the general line, though too desultory, owing to the small amounts appropriated, and the irregular intervals at which these appropriations were made. By the act which became a law August 11, 1888, $5,000 were appropriated. My last report sets forth the reasons why $23,000 was the least that

should be made available. During the fiscal year ending June 30, 1889, $2,121.19 were expended in an endeavor to connect the work of previous seasons in the lower river with some detached work near Poplar Bluff, in the upper river. The season of high water was so near at hand before operations could be begun, that but little could be accomplished during this fiscal year, as it will be apparent to a casual observer that, with so little money, the boat should be operated at low-water stage only. The small balance will be expended in accordance with the original plan early in the next fiscal year. It is hoped that this, in conjunction with the appropriation for "improving Black River, Missouri," will consummate the long looked-for general opening of the river to Poplar Bluff, Mo. It will, however, only remove the overhanging trees and worst obstructions. As such it will be a triumph of persistent effort. The appended statements in regard to commerce, with the facts reiterated so often in former reports in reference to depth of water and permanent banks, seem to call very loudly for the renewal of the recommendation made last year. This was $23,000. Deduct $5,000 appropriated, and we have $18,000, and then, as another year has passed without any appropriation, the annual appropriation of $8,000, which I have recommended in several reports, must be added, making a total of $26,000 that can be profitably expended between the mouth of the river and Poplar Bluff, Mo., during the fiscal year ending June 30, 1891. It should be noted that the $8,000 required annually is principally rendered necessary by the existence of the unimproved reach referred to, which acts as a great feeder of snags that lodge in the improved river below. Evidently sound policy says, attend to the unimproved river at once and save expense in maintaining the improved section.

COMMERCE.

The amount of commerce when work of improvement began may be inferred from the following statement, taken from Annual Report Chief of Engineers, 1880, page 1326:

> From the Upper Black great quantities of staves are taken, and from the Lower Black it is estimated that from 10,000 to 12,000 bales of cotton are shipped to Memphis and other markets, and other shipments (amount not known) go over the St. Louis and Iron Mountain Railroad to St. Louis.

As to effect upon rates of insurance and freight, insurance companies have not acted upon the matter. It is expected the rates will be reduced. The work is just beginning to tell upon the freight and it is too soon to state definitely as to rates. One man representing a large stave factory at Poplar Bluff estimates that rates would be reduced one-half.

As to effect upon rates of competing routes of transportation, this river parallels the St. Louis, Iron Mountain and Southern Railroad for over 100 miles. There can be no question as to water *v.* rail transportation. Reliable parties state that the effect will be marked.

As to prospective advantages to commerce if completed, freight would be increased tenfold. There is a vast tract of land through which Black River runs, the products of which must be transported by river. The country is only just beginning to be opened up and is susceptible, practically, of unlimited developments. It is difficult to estimate the benefits to the community if completed. This river is one of the deepest in the State. As a natural highway it surpasses the Arkansas River. Its banks cave but little, and when the standing timber has been cleared off so that snags do not accumulate, it will not give much

trouble as a navigable stream. It is destined to become in the near future a part of a great parallel transportation line to New Orleans, competing with the Missouri Pacific system of railroads for the traffic of an immense territory.

The confines of such a report as this are too limited to do justice to this river. Were they more extended I doubt if it were possible to forecast the great benefits that will flow from its maintenance as a navigable stream. The gentleman referred to above, writing upon this point, says:

There is no doubt as to the possibilities of the land between Poplar Bluff and the Arkansas line. The country is being settled up very fast, and the sooner we get Black River in a condition to carry the products the sooner the territory will be populated. The timber is good and the soil very rich. Most of the timber that now stands is of a quality that must be carried in barges or on steam-boats, as it will not float to advantage. The proper development of the river means the location of saw-mills along the line with which to work the timber up. This would be followed by settlers to work the soil, which is very rich.

Money statement.

Amount appropriated by act of August 11, 1888	$5,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	2,121.19
July 1, 1889, balance available	2,878.81
Amount (estimated) required for completion of existing project, annually	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	26,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT IMPROVING BLACK RIVER, ARKANSAS AND MISSOURI, DURING FISCAL YEAR ENDING JUNE 30, 1889.

Pay-roll, labor, etc	$1,500.67
Subsistence supplies	249.25
General supplies	86.13
Transportation	2.91
Rent of office	40.00
Fuel	212.75
Traveling expenses	6.30
Stationery	23.18
Total	2,121.19

X 10.

IMPROVEMENT OF BLACK RIVER, MISSOURI.

The first improvements attempted upon this reach of river were made in the years 1881 and 1882. Prior to this work its channel was choked with logs and snags and obstructed by overhanging trees, and in many places shoals interfered with its navigation at low water by any but very light-draught boats. Its banks caved but little, and except at the shoals is characterized by greater depth of water than is found in streams generally in its vicinity, due to its being narrow and its banks firm. The original plan for its improvement contemplated

the removal of the obstructions and the improvement of the shoals, the latter by wing-dams. A few sloughs were to be closed up, so as to confine the water to the main channel. Up to June 30, 1888, $6,000 had been expended, which had opened up about 20 miles of river from Poplar Bluff towards the mouth. Owing to the difficulty in getting suitable appliances up to this reach, it was carried on under great difficulties.

During the fiscal year ending June 30, 1889, the snag-boat *Henry Sheldon*, specially constructed for work on this river, was successfully pushed through to Poplar Bluff, and operated from there down the river, rapidly and effectively clearing the same of obstructions. Six thousand five hundred and sixty-two dollars and thirty cents were expended in the work, erecting a strong dam at the head of Dan River (a chute of the Black River), removing 293 snags, cutting 1,874 overhanging trees, deadening 17,490 trees, and removing 12 masses of drift-wood; carrying the work to the Arkansas State line, removing the greater portion of the dangerous low-water snags, and making a good beginning upon the overhanging timber.

To economize in space, everything that needs to be said in regard to future work has been placed under the general heading, "Improving Black River, Arkansas and Missouri," as that covers the same ground.

I will, however, add that the very effective work that has been done has been due to the snag-boat *Henry Sheldon*, built expressly for this river. This boat will not maintain her present light draught more than eighteen months longer, and it is of the utmost importance in the interests of economy that the snagging operations be completed within that time.

COMMERCE.

See "Improving Black River, Arkansas and Missouri."

Money statement.

Amount appropriated by act of August 11, 1888		$7,000 00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$6,562.30	
July 1, 1889, outstanding liabilities	238.50	
		6,800.80
July 1, 1889, balance available		199.20
Amount (estimated) required for completion of existing project annually		8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		26,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

EXPENSE ACCOUNT IMPROVING BLACK RIVER, MISSOURI, DURING FISCAL YEAR ENDING JUNE 30, 1889.

Pay-roll, labor, etc	$4,444.60
Subsistence supplies	866.40
General supplies	929.08
Transportation	14.41
Traveling expenses	197.98
Fuel	64.00
Telegraph service	12.30
Stationery	33.53
Total	6,562.30

X II.

IMPROVEMENT OF ST. FRANCIS RIVER, ARKANSAS.

Earliest appropriation made for this river under any head was made by act approved March 2, 1833. Summing up all the various works of improvement, it may be inferred that prior to 1833 this river was much choked with drift-piles, logs, and snags, and its waters spread out through a great variety of sloughs, while overhanging trees added to the difficulties of navigation. In the originally adopted project snagging operations figured largely, and attempts have been made to close up some of the many sloughs. This river has been united so often with the White River and also with the Black that it is impossible to give exactly how much had been expended upon the St. Francis River to June 30, 1884.

By act approved July 5, 1884, $12,000 was appropriated for the entire river; $8,000 was added to this by act approved August 5, 1886. A light-draught snag-boat, equipped with powerful machinery, was constructed out of these funds and a large number of dangerous obstructions were removed up to June 30, 1888, with a balance on hand at that date of $3.38.

By the act which became a law August 11, 1888, $4,000 were appropriated for the continuance of the improvement, after the originally adopted project. During the fiscal year ending June 30, 1889, $1,883.77 were expended in snagging operations between the towns of Kennett, Mo., and St. Francis, Ark. This carried the boat to the beginning of the work under the head of "Improving the St. Francis River, Missouri." As the boat has no propelling power, she was at once transferred to the work on this other reach and kept engaged there during the balance of the fiscal year ending June 30, 1889, being worked, of course, at such times as the water was at a suitable stage. After the work on the upper reach is completed the boat will be moved down the river and the balance expended in accordance with the originally adopted project, removing the worst obstructions to the mouth of the river, thus carrying out in a general way the policy outlined for this river, which is to expend about $8,000 annually until it is thoroughly opened up.

It is scarcely proper to include in this report anything that is a reiteration of that of last year, yet, as the appropriation for the year ending June 30, 1891, will be largely based upon this report, I feel it my duty to invite special attention to the report of 1887, as it contains very full information on all points connected with this work of improvement.

Dynamite in small charges of one-half pound each has been very successfully used upon this work during the present fiscal year. Where the obstructions are not over 18 inches under water it is a very effective and economical agent. The method of use was to bore into the stumps or logs with augers, provided with long shanks for the purpose, insert a half pound charge of dynamite and explode with a water-proof fuse and a detonating cap.

The more study I have given the stream and the country, the more interesting the study becomes and the more convincing the arguments in favor of opening up the river. With no transportation except the wagon, a fertile section, rapidly settling up between Lester's Landing and St. Francis, would at once pour out through this channel its products, adding many times the sum required for the improvements to the material prosperity of the country. Whatever decision may be rendered as to the desirability of further expenditure, the river now has a plant

of its own, peculiarly adapted to its work, and can be cared for at a very small outlay. It would be better to put the river in excellent shape before the plant deteriorates, and it is believed that after a few years of thorough work the river will maintain itself. As to future demands, the development of the country can alone decide what these will be. It may be that dredging the sunk lands, to bring the river back to its own channel, may be warranted in years to come, and that low-water navigation may be demanded. At present the prospect is too remote to devote time to plans and estimates for these improvements.

The recommendation of last year is renewed, and as one year has passed without the annual $8,000 being appropriated, $16,000 can be profitably expended during the fiscal year ending June 30, 1891. The work is being carried on systematically and effectively, but there is much yet to be done. No where in the State will the results be any more direct, nor is there any section where the amount necessary to improve the stream is any smaller in proportion to the benefit to be conferred.

COMMERCE.

The facts set forth under the report upon "Improving St. Francis River, Missouri," should be read in this connection. The following letter is very pertinent, and my own observation corroborates Mr. Sanders's statements.

KENNETT, DUNKLIN COUNTY, MO., *January* 15, 1889.

SIR: I beg leave to acknowledge, with thanks, the receipt this day of your Annual Report upon the improvement of certain rivers in Arkansas and Missouri in your charge.

I note with great pleasure your remarks and recommendations touching the improvement of the St. Francis River, in which I am of course particularly interested.

As you very pertinently state, "the more study which is given to this stream and the country the more interesting the study becomes, and the more convincing the arguments in favor of opening it up."

The country tributary to the St. Francis, more especially on its eastern side, is to the world at large a veritable "Terra Incognita." That such a large body of land of untold fertility, clothed with large forests of magnificent timber of the highest market value, could so far have escaped discovery, save by a small number of pioneers, is like a romance. In regard to opening up this country and supplying it with facilities for transportation, one item of paramount importance should be kept in view, and that is, that whether accomplished by railway or steam-boat, to be of greatest value, it should be done at once, and for the reason that every year hundreds of thousands of dollars' worth of the most valuable merchantable timber is being destroyed by "deadening" or by cutting down and burning in order to clear up land for farming or agriculture; in a word, by far the most valuable "crop" which will ever be produced upon these lands stands upon them now, only useless because of no means of transporting that "crop" to market.

From a personal acquaintance and close examination of this country, running back through a period of more than fifteen years, I have made an approximate estimate of the possible value of this timber, and I find that there is now standing upon the uncleared lands of this section of country sufficient marketable timber to pay for clearing, fencing, and erecting the very best of all necessary dwellings, outhouses, stables, and cattle-sheds, and in fact to convert the land into first-class, well-improved farms of the very highest grade of fertility, and leave a balance on hand to pay the taxes for years, and this remarkable source of wealth is annually being absolutely destroyed simply because there is no means of getting it to market. Only think of a worm-fence ten rails high, with stakes and riders made of black walnut or cherry rails.

In figuring on this problem it is not fair or right to ask what is the value of the agricultural products of this country, or what it is likely to be in the future, but the question should be, "What is the value of the timber already on the land and waiting for means to get it to market?" Waiting, I say! that is incorrect, it is not waiting, for people can not eat timber, even though it be bird's-eye walnut or curly maple, neither can they sell it without means of transporting it to market, and they must perforce destroy all this valuable and ready-grown crop in order that the land may be converted into farms upon which something can be grown which may be utilized.

I trust you will pardon the liberty I have taken in thus lengthily expressing my opinion and views in the premises, but it seems to me a matter of such great importance as to demand investigation and recognition.

In conclusion, if at any time I can be instrumental in assisting in any way in this work, I will most cheerfully respond to your commands.

Respectfully,

ROBT. F. SANDERS.

Capt. H. S. TABER,
Corps of Engineers, U. S. A.

Money statement.

July 1, 1888, amount available	$3.38
Amount appropriated by act of August 11, 1888	4,000.00
	4,003.38
July 1, 1889 amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	1,888.77
July 1, 1889, balance available	2,114.61
Amount (estimated) required for completion of existing project annually	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	16,000.00
Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT IMPROVING ST. FRANCIS RIVER, ARKANSAS, DURING FISCAL YEAR ENDING JUNE 30, 1889.

Pay-roll, labor, etc	$1,061.51
Subsistence supplies	338.57
General supplies	311.92
Transportation	19.96
Traveling expenses	133.00
Fuel	2.59
Telegraph service	.82
Stationery	20.40
Total	1,888.77

X 12.

IMPROVEMENT OF ST. FRANCIS RIVER, MISSOURI.

The appropriation available is the first ever made for this reach of river. Prior to the work done in the fiscal year ending June 30, 1889, its channel was choked with logs and snags, overhanging trees interfered with smoke stacks, and several shoals interfered with low-water navigation. The estimate, $7,300, proposed the removal of the shoals about 12 miles below Greenville, and the removal of snags and other obstructions by a snag-boat to the town of St. Francis, Ark. The present project contemplates the removal of snags and other obstructions only, as the amount appropriated, $5,000, by act which became a law August 11, 1888, is not large enough to warrant attempting the shoals also. During the year ending June 30, 1889, $3,062.21 were expended cutting a channel through 600 feet of drift-wood, removing 216 snags, cutting 50 overhanging trees, carrying the work from the town of Greenville, Mo., to a point between Wappapello and Poplin, Mo. Much delay was experienced due to the obstruction offered by the railroad bridge over the St. Francis River at St. Francis, Ark. This was overcome

finally by the reconstruction of the boat, by which the upper portion of the cabin was made movable. The operations, so far, have taken out the dangerous low-water snags, cut the overhanging timber over the reach specified, and the boat is in good order to continue the work in the next fiscal year down to the town of St. Francis, Ark. Her success so far warrants the belief that the snagging and removal of overhanging timber will be about completed. To complete it and to remove the shoals, the balance originally estimated, $2,300, will be required, and as the plant may have to be cared for, or cost extra to move it to its work, a contingent of $200 should be added, making $2,500 all told, required to complete the existing project.

It is hardly necessary to occupy space to comment upon the value of the improvement to the commercial interests, as it is simply going over the ground contained in the appended statement in regard to commerce, but this should be as carefully considered as the report itself.

As considerable correspondence occurred relative to the use of the United States snag-boat *A. B. Johnson*, I wish to invite special attention to the fact that she overcame the 600 feet of big drift in less than a month, for less than $700, when it was predicted it could not be done for less than $10,000; and also to invite attention to the large quantity of obstructions removed already, and this despite the loss of a week's time, due to an unexpected rise in the river. There were no gauge records, but it was the writer's good fortune to hit the right season for low-water work, with the results as stated.

COMMERCE.

The records do not show what the amount of commerce was before any work was done upon this river. As the river was almost entirely choked with snags, logs, and overhanging trees, it must have been very small, and from the best authority I have been able to secure, amounted to a few staves, taken out by flat-boats propelled by hand.

Good authorities familiar with the river state that if the river was properly improved freight would be reduced from $1 per hundred by wagon to 30 to 35 cents per hundred by boat. From what precedes it will be seen that there are no competing public routes. The territory drained by this river is almost entirely dependent upon the river for transportation.

As to prospective advantages to commerce if completed, they are practically beyond computation. Four letters in my possession, from individuals quite widely separated, all agree upon one point, namely, that the products of the country, and hence its commerce, would be increased 100 per cent. annually, were the river improved according to the present plans.

Some idea of the general benefits to be conferred upon the community by the completion of the works may be formed from the fact that, with the river only about half prepared for navigation, there was shipped in 1885 and 1886, in the extreme upper part of it, 500 tons of merchandise, 600,000 staves, and 700,000 feet of lumber.

Extending the limit a few miles lower, and we have as the present yearly commerce—

Lumber	$3,150,000
Staves	225,000
Cotton	450,000
Corn	300,000
Pork	300,000
Potatoes	100,000
Miscellaneous	300,000

From the lower two-thirds of the river, during medium and high water stages, there is shipped weekly 25,000 bales of cotton, 250,000 sacks of cotton seed, and about 175 tons of merchandise. Comments as to benefits are unnecessary. This is one of the most deserving rivers in the State.

Several letters in my possession go to show that the money expended with light-draught boats, since 1884, has produced great changes in navigation. Most flattering words are used in reference to the effectiveness of the work, and strong language used as to the desirability of completing the present project, in view of the good already accomplished.

Money statement.

Amount appropriated by act of August 11, 1888		$5,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$3,062.21	
July 1, 1889, outstanding liabilities	406.75	
		3,468.96
July 1, 1889, balance available		1,531.04
Amount (estimated) required for completion of existing project		2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

EXPENSE ACCOUNT IMPROVING ST. FRANCIS RIVER, MISSOURI, DURING FISCAL YEAR ENDING JUNE 30, 1889.

Pay-roll, labor, etc	$2,152.46
Subsistence supplies	420.67
General supplies	281.00
Transportation	4 66
Traveling expenses	168.98
Telegraph service	7.57
Stationery	23.52
Fuel	3.35
Total	3,062.21

X 13.

IMPROVEMENT OF LITTLE RIVER, MISSOURI AND ARKANSAS.

The first appropriation ever made for this river was that of the act which became a law August 11, 1888, amounting to $5,000 (five-eighths of the estimate, $8,000). The project for improvement contemplates rendering it navigable at high and medium stages from Hornersville to its junction with the St. Francis River, especially to prolong the medium stage of water by confining the water to one of the two chutes making out of the lake upon which Hornersville is situated, and by removing the snags, logs, and masses of drift-wood that have accumulated in the channel. The project for the expenditure of the $5,000 referred to above, provides that it be expended as follows, viz, $1,500, or as much as may be necessary, in building a dam across one of the chutes at or near the lake, and the balance in removing the worst obstructions in the way of overhanging trees, logs, snags, and drift over the distance speci-

fied; and that the snag-boat *A. B. Johnson* be used for this work, being transferred in due form and by proper authority and at the proper time for this purpose, the dam to be constructed of brush and gravel, brush and rocks, or of such other material as may be had in the locality as may be best adapted to the purpose.

The works to be executed by hired labor and the purchase of material in open market, as this is most economical and advantageous to the Government.

It will be seen that this provides for the use of the snag-boat *A. B. Johnson*. During the fiscal year ending June 30, 1889, no work was done under this head, inasmuch as the snag-boat *Johnson* had not completed its work on its own river, the St. Francis. This was what was expected, as it will be seen that if the boat that operates on this river costs $4,000, and one can be borrowed, it is the best policy to wait until such boat can be obtained. It is probable that this boat will be available within the next six or eight months, when thorough work can be done of lasting benefit to the river. It is recommended that the balance of the $8,000 be appropriated in season to be used with the sum now on hand.

COMMERCE.

Hornersville ships yearly about 20,000 bales of cotton, 500,000 bushels of grain, and a good quantity of stock. This is the only outlet this section has, except wagons. Like many other streams in this State, it has upon its banks some very fine timber, which only waits a free waterway to find a ready market. Hornersville is backed by a large tract of improved country, whose main distributing point it is. The waterway itself is partly a lake and partly two narrow rivers. The lake extends about 12 miles from Hornersville. This lake is drained into the St. Francis River by two chutes that are known together as Little River.

It is too soon to give effects upon rates of insurance and freight. It has no competing routes of transportation.

As to prospective advantages to commerce and benefits to community if completed, there will be the same results in a general way as enumerated for St. Francis River, as it is one of its feeders.

Money statement.

Amount appropriated by act of August 11, 1888	$5,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	29.69
July 1, 1889, balance available	4,970.31
Amount (estimated) required for completion of existing project	3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	3,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

EXPENSE ACCOUNT OF IMPROVING LITTLE RIVER, MISSOURI AND ARKANSAS, DURING FISCAL YEAR ENDING JUNE 30, 1889.

General supplies	$29.69

APPENDIX Y.

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI AND MISSOURI RIVERS—IMPROVEMENT OF THE MISSISSIPPI BETWEEN THE MOUTHS OF THE ILLINOIS AND OHIO RIVERS—IMPROVEMENT OF OSAGE AND GASCONADE RIVERS, MISSOURI.

REPORT OF MAJOR A. M. MILLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Removing snags and wrecks from the Mississippi and Missouri rivers.
2. Mississippi River between the Ohio and Illinois rivers.
3. Gasconade River, Missouri.
4. Osage River, Missouri.

EXAMINATIONS.

5. Grand River, Missouri.
6. St. Louis Harbor, Missouri.
7. Missouri River at Miami, Missouri.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., July 8, 1889.

GENERAL: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1889, for the works under my charge.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Y 1.

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI AND MISSOURI RIVERS.

The work for the fiscal year consisted in the removal of snags, logs, leaning trees, wrecks, etc., between the mouth of the Missouri River and Natchez, Miss.

As it was not considered safe to put the snag-boat *H. G. Wright* in commission until new boilers had been placed in her, the snag-boat *J. N. Macomb* alone was sent out at the beginning of the season. On

November 1 the snag-boat *E. A. Woodruff* was loaned by Lieut. Col. Wm. E. Merrill, Corps of Engineers, for this work, remaining in the river for three months, and rendering much needed assistance in removing obstructions, one snag-boat not being able to keep the channel free from snags, etc.

In May the snag-boat *Wright*, having had her new boilers put in, made one trip between St. Louis and Cairo, being out 12 days. This was owing to the unusually low stage of the river at this time. It is not usual for the river to be low enough for snagging until August or September.

The snag-boat *Macomb* began work on August 20, and continued in commission until February 27, having worked between mouth of Missouri River and Natchez, Miss.

The snag-boat *Woodruff* began work in the Mississippi River on November 1, continued until January 31, and worked between St. Louis, Mo., and Memphis, Tenn.

The work accomplished by the snag-boats is given in the following table:

Name of snag-boat.	Snags pulled.	Trees cut.	Drift piles removed.	Wrecks removed.	Miles run.
J. N. Macomb	1,387	6,313	33	.....	3,728
E. A. Woodruff	376	2,199	.....	8	1,886
H. G. Wright	101	590	1	.....	416
Total	1,864	9,102	34	8	6,030

Much-needed repairs were made to the snag-boats *Wright* and *Macomb*. New boilers were placed in the *Wright*, a new butting beam was put on the *Macomb*, both boats were docked and thoroughly overhauled and painted throughout, and are now in good condition and ready to be put in commission as soon as the needs of commerce require.

The work accomplished by the snag-boats is of great benefit to the navigation of the river. Formerly the wreck of steam-boats by running on snags was a very frequent occurrence, but since the snag-boats have been at work it is almost unheard of.

An annual appropriation of an amount not to exceed $100,000 having been made for carrying on this work, the snag-boats will be put in commission, and will patrol the river whenever the demands of commerce require and the stage of water will permit, and will keep the channel clear of obstructions.

Money statement.

July 1, 1888, amount available		$3,772.47
Amount appropriated by act of August 11, 1888		100,000.00
		103,772.47
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$67,511.37	
July 1, 1889, outstanding liabilities	3,289.15	
		70,800.52
July 1, 1889, balance available		32,971.95

MISSOURI RIVER.

No work was done under the supervision of this office during the year.

By the terms of the river and harbor act of August 11, 1888, this work was placed under the Missouri River Commission, and the snag-boat *C. R. Suter* and other property belonging to the work were transferred to Lieut. Col. C. R. Suter, Corps of Engineers, president Missouri River Commission, on September 28, 1888, by direction of the Secretary of War.

Money statement.

July 1, 1888, amount available	$2,748.25
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	765.45
July 1, 1889, balance available	1,982.80

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE OHIO AND ILLINOIS RIVERS.

PROJECT.

The object of the improvement is to obtain a minimum depth at low water of 6 feet from the mouth of the Illinois River to St. Louis, a distance of 41 miles, and 8 feet from St. Louis to the mouth of the Ohio River, a distance of 191 miles, the natural depth at low water being in many cases from 3½ to 4 feet. The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, working down-stream from that city. Work at detached points has also been carried on under allotments specially made by law for the improvement of landings and the protection of local interests.

The plan of general improvement contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis (the natural width being in many cases from 1 to 1½ miles) and the protection of alluvial banks from erosion. The methods employed are to build up new banks with the solid matter caught from the river itself by means of hurdles, and revetment of the banks, both new and old, when necessary.

ORGANIZATION.

The organization of the engineering staff during the season was as follows:

A supervising engineer was assigned to the general supervision of all the works and of the supply depot; his office was in St. Louis, and his duties were to advise and direct the resident engineers, and to have special charge of the supply of brush, stone, and piles, and of the tow-boat and barges engaged on the work.

The resident engineer was provided with quarters and an office at the work. His duties were to have immediate direction of the work of construction; to make such surveys and observations as might be required to keep the progress map, upon which all work was to be located as

fast as constructed; to keep the journal and other records of the work, to prepare pay-rolls, to render quarterly property returns, semi-annual and annual reports to the officer in charge, forwarding them through the superintending engineer.

The superintending engineer was Mr. D. M. Currie. Resident engineers: At Pulltight, Mr. William S. Mitchell; at Lucas, Mr. John O. Holman; and for revetment work at Twin Hollows, contraction work at Sulphur Springs and Jim Smith's, also procurement of brush, Mr. C. D. Lamb.

WORK ACCOMPLISHED.

The work laid out for the fiscal year under the approved project was the repair of hurdle No. 4 at Pulltight, the extension of hurdles Nos. 1 and 2 at the same locality, the extension and repair of hurdles at Sulphur Springs and Jim Smith's, the commencement of the new system at Lucass's, and the removal of a portion of the dam at Piasa Island. Owing to the unfavorable condition of the river no work was done at this last-named locality.

Plate I is a general map of the river between the St. Louis Bridge and Calico Island, showing the location of these works.

HORSETAIL.

The work in this reach consisted in the repair of the hurdle designed to close the chute to the east of this island. During the winter the hurdle had been damaged by ice and partially burned by hunters or fishermen. These damages were repaired and the revetment at the head of Carroll's Island strengthened; 450 linear feet of hurdle was built and $4,093.58 expended. These repairs were completed September 15, 1888, and have since remained intact and resulted in a large fill, which will probably, after next high water, close this chute at the 20-foot stage on the St. Louis gauge. The improvement of this locality may be considered as complete unless some unforeseen accident occurs to the work at Carroll's Island. The river has been contracted to a width of 2,500 feet and an average fill of about 12 feet secured over an area of 1,000 acres on the east side, where steam-boats were frequently aground at low water and the channel exceedingly tortuous; there is now an easy, well-defined channel, and pilots do not even cast the lead. For a distance of 7,000 feet from the river Des Peres down-stream the contraction works have been carried out from both banks, the new bank having been revetted on the west side. This shows what may be accomplished by this system when funds are available for continuous work. When a stretch of works can only be partially completed and left for want of funds the repairs are a very considerable item of expense. Plate II shows the hurdle at the head of Carroll's Island.

TWIN HOLLOWS.

The work at this locality consisted in the continuation of the revetment of the new bank, near its head, for a distance of 1,750 feet; 115,450 square feet of protection, consisting of brush mattress and stone, were placed in position at a cost of $7,817.65. The channel in this locality is in very good condition, and navigation has been greatly benefited by the works, which consist in contraction on the west side and protection on the east bank.

The area covered by material deposited is 361 acres, of which 251 acres appear above the 15-foot stage on the St. Louis gauge, covered with a vigorous growth of willows. There are still some sloughs in this

area at high water, but these are gradually becoming closed by silt. (See plate II.)

PULLTIGHT.

The original project for this locality was to send the channel down the east side of the river, by Beard's Island, making a crossing to the west side at Fine's Bluff, just above the mouth of the Maramec River. A study of this locality showed that the natural tendency of the river was to make the crossing above this point at White House, and at low stages there was a tendency to shoal; it was thought best to close the east side of the river by constructing hurdles and throw as much water as possible into the White House crossing and improve and preserve this. With this view two hurdles were laid out and constructed, the first in prolongation of No. 4 of the Pulltight system and the second 2,800 feet below. These two hurdles were constructed during the fiscal year ending June 30, 1888. It was found, however, that this did not cause the crossing to take place high enough up-stream to cross the middle bar, but caused the channel to follow at low water along the upper hurdle, making a very abrupt turn at the west bank of the river at White House, and by its scour weakening and damaging the hurdle. Two other hurdles in continuation of Nos. 1 and 2 of the Pulltight system were projected and built during the fiscal year ending June 30, 1889. No. 2 was placed 2,000 feet above No. 4, and No. 1, 1,200 feet above No. 2. Hurdle No. 1 was completed May 9 for a length of 1,500 feet, and on May 14 hurdle No. 2 to a distance of 1,275 feet from the east bank.

Considerable difficulty was met with in the construction of these hurdles on account of the deep water and swift current in the channel which they were designed to close. A rapid rise in the river occurring in the latter part of May caused a very heavy run of drift, which hurdle No. 1 could not withstand; it broke about middle point, making a gap of about 150 feet in width, and thus allowing the accumulation of drift and débris to rush against hurdle No. 2; this latter, as well as No. 4 of last year's work, was broken; immediate steps were taken to repair this damage by the concentration of plant from Jim Smith's, and afterwards Lucas's, and on June 30 the repairs to hurdle No. 2 were complete and No. 1 repaired with the exception of a short gap and a portion of the outer extremity. On account of these mishaps the cost of the work at this locality has exceeded the estimate. The work now appears to be producing the desired effect, as it has caused the draught of water to take the desired direction, which should cut a good low-water channel through the middle bar. The channel depth at this locality for a few days last September, 20, 21, and 22, the river being low, St. Louis gauge about 7 feet, the channel depth at the head of the middle bar was as low as 5½ feet, but as above mentioned the channel then changed to a crossing, following hurdle No. 4, and a depth of 8 feet was maintained. At this time an attempt was made to deepen the channel at the upper crossing by means of the water jets from pile-drivers lashed together and the wrecking pump of the steam-boat *T. F. Eckert*, but with no appreciable success.

The amount expended at this locality during the fiscal year ending June 30, 1889, was $104,495.96. (See plate II.)

CHESLEY ISLAND.

The work at this locality consisted in closing the chute to the west of the island below the mouth of the Maramec River. No work was done dur-

ing the fiscal year. The work is in good condition, and has succeeded in closing the chute so that it is dry, except a small portion at the lower end, at a 15-foot stage of the St. Louis gauge. (See plate III.)

JIM SMITH'S.

The project for the improvement of the river at this locality consists in the construction of contraction works. On account of the existence of a very persistent middle bar, it was determined to further extend the hurdles on the east side in order to close the chute to the east of this bar and concentrate the water in such a manner as to remove it. Two hurdles, No. 6 and No. 6½, were extended, work beginning May 9 on hurdle No. 6½. This was completed, with the exception of wattling, for a length of 700 feet from shore; hurdle No. 6 was completed for a length of 500 feet, when on June 11 the force and plant at this point were transferred to Pulltight to assist in the repairs at that point. This work will be continued as soon as the plant is available. The work was somewhat damaged by the May rise, which destroyed about 300 feet of completed work.

Amount expended during fiscal year ending June 30, 1889, was $14,079.66. (See plate III.)

SULPHUR SPRINGS.

The work at this locality is contraction work, the hurdles extending from the east bank. The project for this locality contemplated the extension and repair of the hurdles by bringing them out to the 2,500-foot line. They had been damaged by ice and drift at their outer ends. The plant being needed elsewhere the only work accomplished has been the wattling of hurdle No. 16, head of Foster's Island, up to the 22-foot stage. This hurdle, completed in 1888, had caused a fill of about 6 feet over the area affected by it.

The work at Sulphur Springs has very much improved the lower crossing. At this locality the boats at low water were frequently compelled to stop and back in making the crossing. The crossing is now easy and no difficulty is here encountered. The works are causing a strong tendency to remove the tow-heads opposite the town of Sulphur Springs. The amount expended during the fiscal year ending June 30, 1889, is included in the amount given for Jim Smith's. (See plate III.)

LUCAS'.

The project for work at this locality was adopted in 1888; it is a new work; the object to be attained is the contraction of the river on the Lucas crossing. This crossing has always given trouble to steam-boat traffic. A large portion of the water is wasted by flowing behind Calico Island, and a middle bar divides what is left into two or more channels of small depth and tortuous direction. Four hurdles were constructed here from the east or Illinois shore. No. 1, 1,500 feet; No. 2, 1,580 feet, No. 3, 1,890 feet, and No. 4, 2,550 feet in length, or a total length of hurdles of 7,170 feet. The work began here on March 6, and these hurdles were completed June 25; the distance between hurdles 1, 2, and 3, is 1,000 feet, and between 3 and 4, 1,500 feet. It is thought best not to extend this system until the effect of the work constructed is observed, as it may not be necessary to build more hurdles if these suc-

ceed in turning the water as desired; two, or possibly three more hurdles were contemplated in the original project.

The works are of too recent construction to give any data as to results produced, which can not be determined until the effects at low water have been observed. Amount expended during fiscal year ending June 30, 1889, was $67,427.60. (See Plate III.)

MATERIAL.

Brush and poles used were procured partly by hired labor and partly by contract from Mr. Nathan W. Tucker, at 95 cents per cord for brush and $1.47 per cord for poles.

Stone was procured by contract with the Grafton Quarry Company, at 40 cents per cubic yard.

Piles were obtained by contract with Mr. Nathan W. Tucker at prices varying from 5 to 7 cents per linear foot according to length.

Rope, iron, wire, bolts, spikes, etc., were obtained by contract from various parties as per abstract of bids appended. Subsistence and miscellaneous stores were purchased in open market on bids from various dealers.

SUPPLY DEPOT.

The supply and subsistence department was under the immediate charge of Mr. S. S. Van Norman. All supplies except brush, stone, and piles, as obtained were delivered at the depot, whence they were distributed on requisition to the various works. In addition to this function of the depot it was a general repair shop, where all repairs to plant, not requiring dockage, were made. During the season the steamer *General Gillmore*, three barges, and nineteen pile-drivers received extensive repairs; other plant ordinary repairs. Forty-two skiffs and twenty-five flats were built.

The present valuation of the property remaining to be distributed on installation account is given in the following table:

Class of property.	Balance June 30, 1888.	Debits.	Credits.	Balance June 30, 1889.
Barges, model and flat	$49,772.19	$10,702.49	$18,085.98	$42,418.70
Boat, machine-shop	1,613.14	119.38	.....	1,732.52
Boats, quarter	1,405.44	368.31	868.31	905.44
Boats, small	4,630.64	11,297.43	6,527.30	9,400.77
Drivers, pile	33,426.62	5,311.68	11,118.47	27,619.83
Machinery steamer *Humphreys*	6,000.00	.....	.....	6,000.00
Shanties, portable	11,587.05	888.28	2,773.26	9,702.07
Steamer *General Gillmore*	14,286.80	17,789.50	18,675.61	13,400.69
Tents	190.75	.....	.....	190.75
Ways for mattress	1,318.31	226.86	653,66	891.51
Supply depot	3,605.33	1,103.47	853.11	3,855.69
Tools and appliances	1,974.05	2,292.06	1,770.92	2,495.19
Boarding outfit	10,055.41	1,475.23	2,342.56	10,188.08
Office furniture	410.47	100.00	87.99	422.48
Surveying instruments	574.21	9.50	118.60	465.11
Photographic apparatus	200.48	.....	.....	200.48
Total	142,050.89	51,684.19	63,845.77	129,889.31

GAUGES.

The gauges at Grafton and Gray's Point were read daily during the season. The readings are appended, marked A.

CONDITION OF THE RIVER.

The channel depths, as furnished by the Mississippi and Ohio River Pilots' Society, during the low-water season, are appended, marked [illegible]. The river was open for the whole year, not having been closed to navigation by ice during the year. The low-water season continued from the 1st of August, 1888, till about the 20th of May, 1889; the water fell to a reading of 7.80 feet on the St. Louis gauge on May 12; this is the lowest recorded water for this month since, and including, 1861, previous to which there are no records in this office.

REPORTS OF ASSISTANTS.

There are submitted herewith the reports of the superintending engineer, Mr. D. M. Currie, and of the assistant engineers, by reference to which all details and particulars can be obtained.

Plate IV shows details of construction for hurdle work.

ESTIMATE.

The amount that can be profitably expended during the year ending June 30, 1891, is $1,000,000. It is proposed to expend this sum in carrying out the programme heretofore adopted; that is, to carry on the work of improvement continuously from St. Louis down-stream, reclaiming land by building up new banks, thus reducing the river to an approximate width of 2,500 feet, alluvial banks to be protected from erosion. It is proposed by this means to obtain a channel of at least 9 feet at low water. The depth now is liable to become as small as 4 feet or even less in some places, and less than 8 feet at every locality where the width is more than 2,500 feet. In my last report I asked for the same amount, but the river and harbor act of August 11, 1888, appropriated only $300,000. With this sum it was not possible to make the proper progress necessary for so important a work, and the steam-boat interests are suffering from such small appropriations.

This general statement of the proposed application of the appropriation is as specific as the nature of the case admits. The changeable character of the river renders it impracticable to give in advance the exact locality where works will be required.

The original estimated cost of this work as revised in 1883 was	$16,997,100
The aggregate amount appropriated to June 30, 1889, is	4,039,600
The amount expended to June 30, 1888, is	3,648,150

ABSTRACT OF APPROPRIATIONS MADE FOR PRESENT PLAN OF IMPROVEMENT.

By act of—	
March 3, 1873	$200,000
June 23, 1874	200,000
March 3, 1875	200,000
August 14, 1876	229,600
June 18, 1878	260,000
March 3, 1879	215,000
June 14, 1880	320,000
March 3, 1881	620,000
August 2, 1882	600,000
July 5, 1884	520,000
August 5, 1886	375,000
August 11, 1888	300,000

Plate 1.

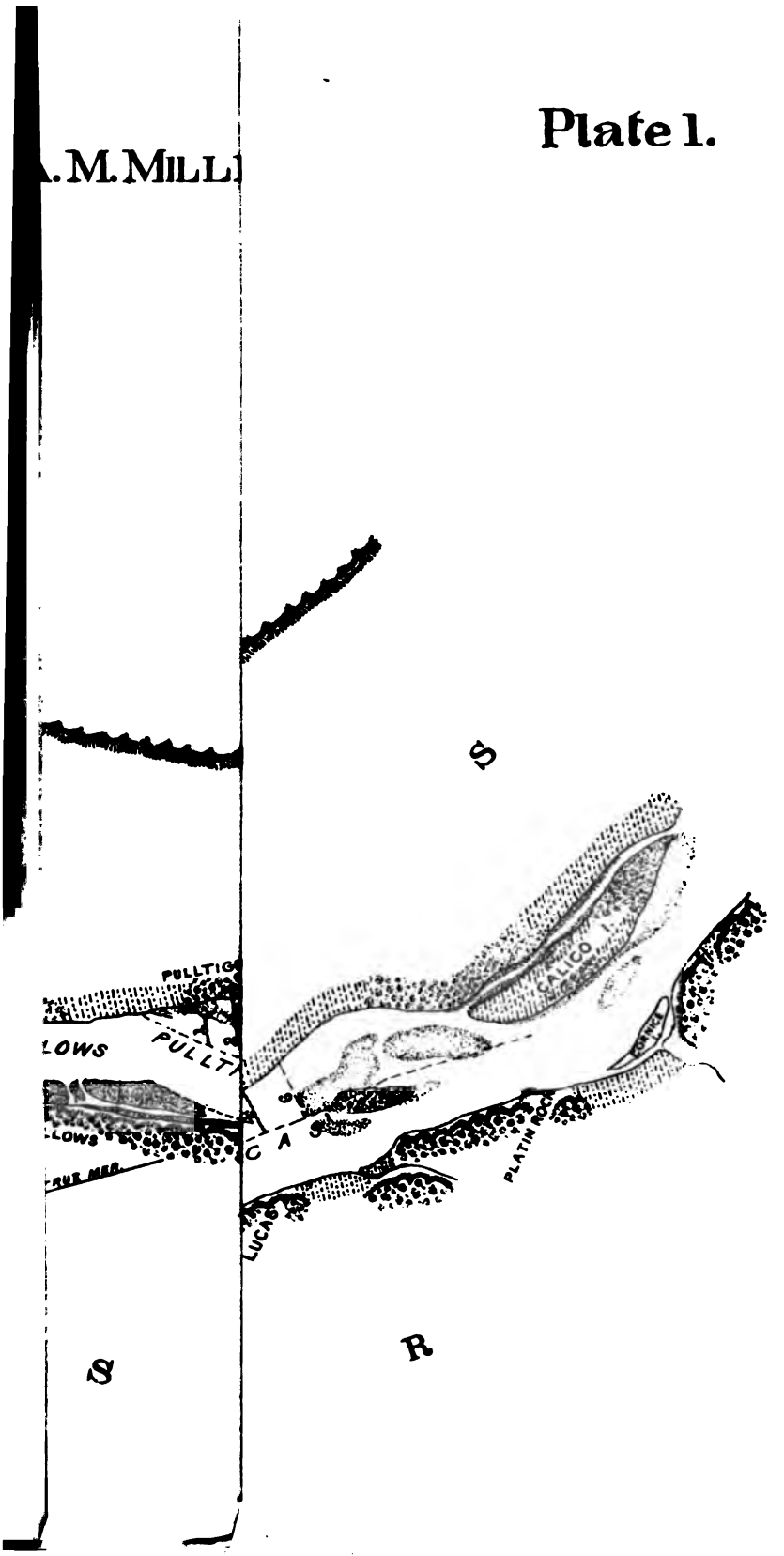
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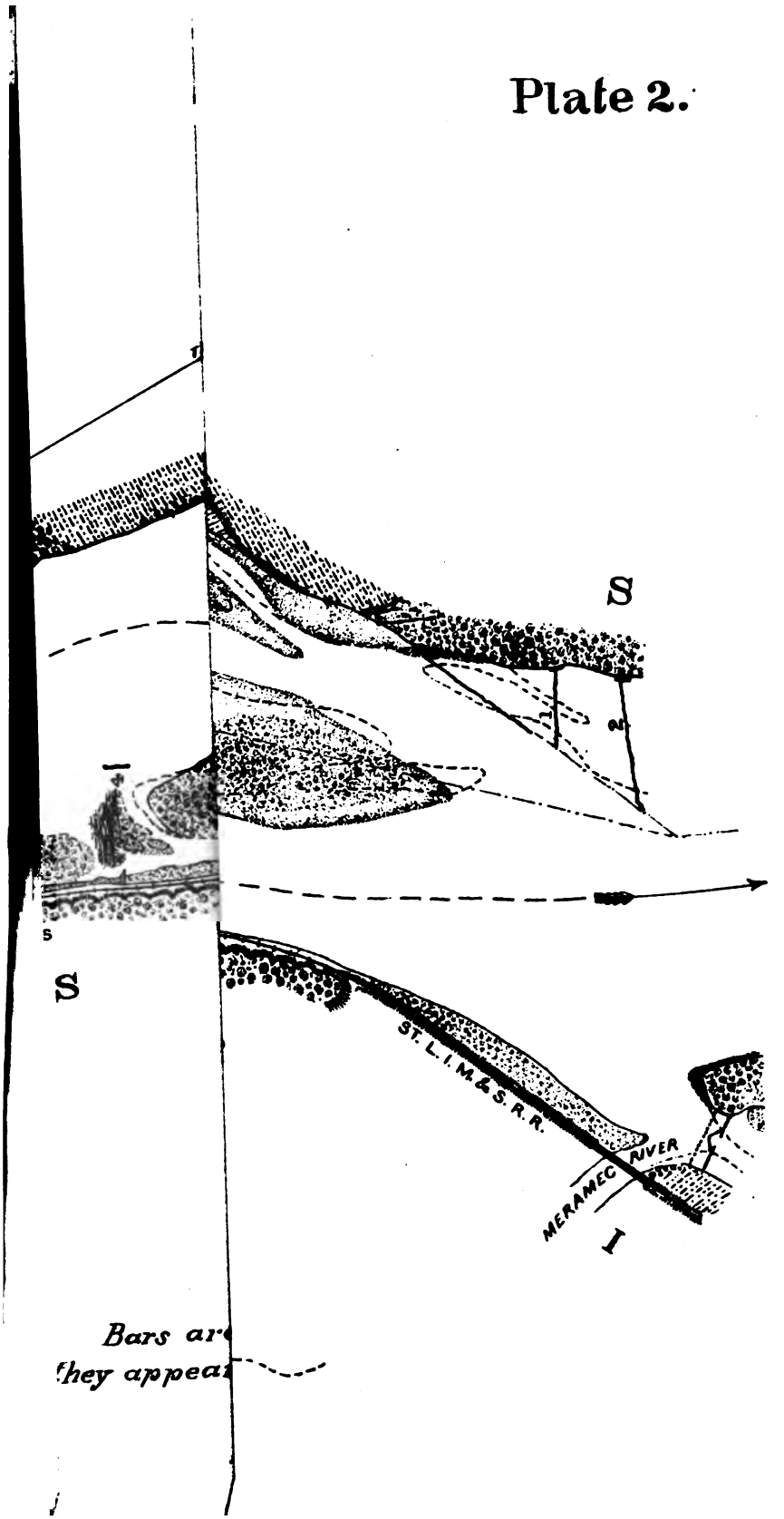
Plate 2.



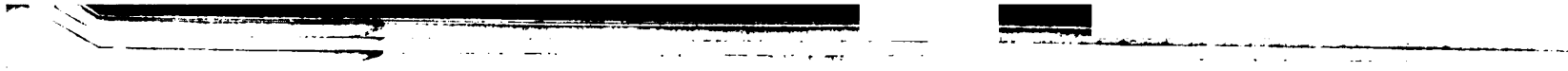
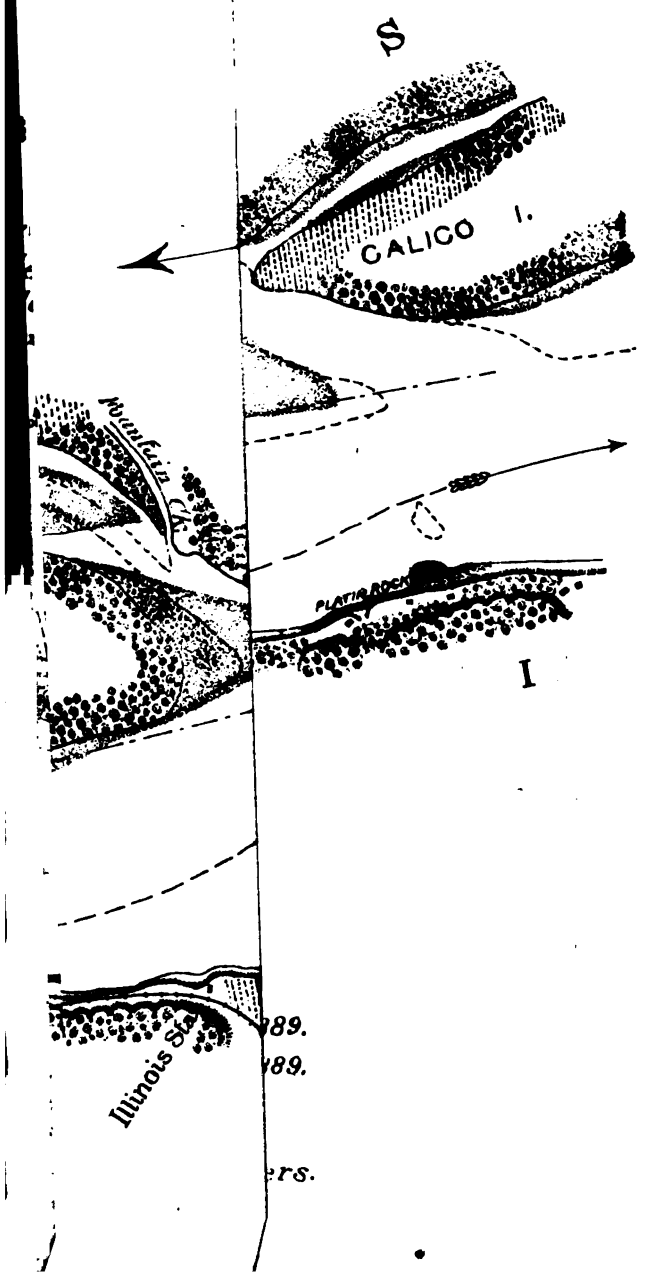


Plate 3.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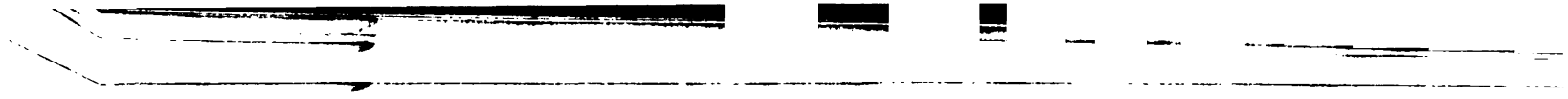
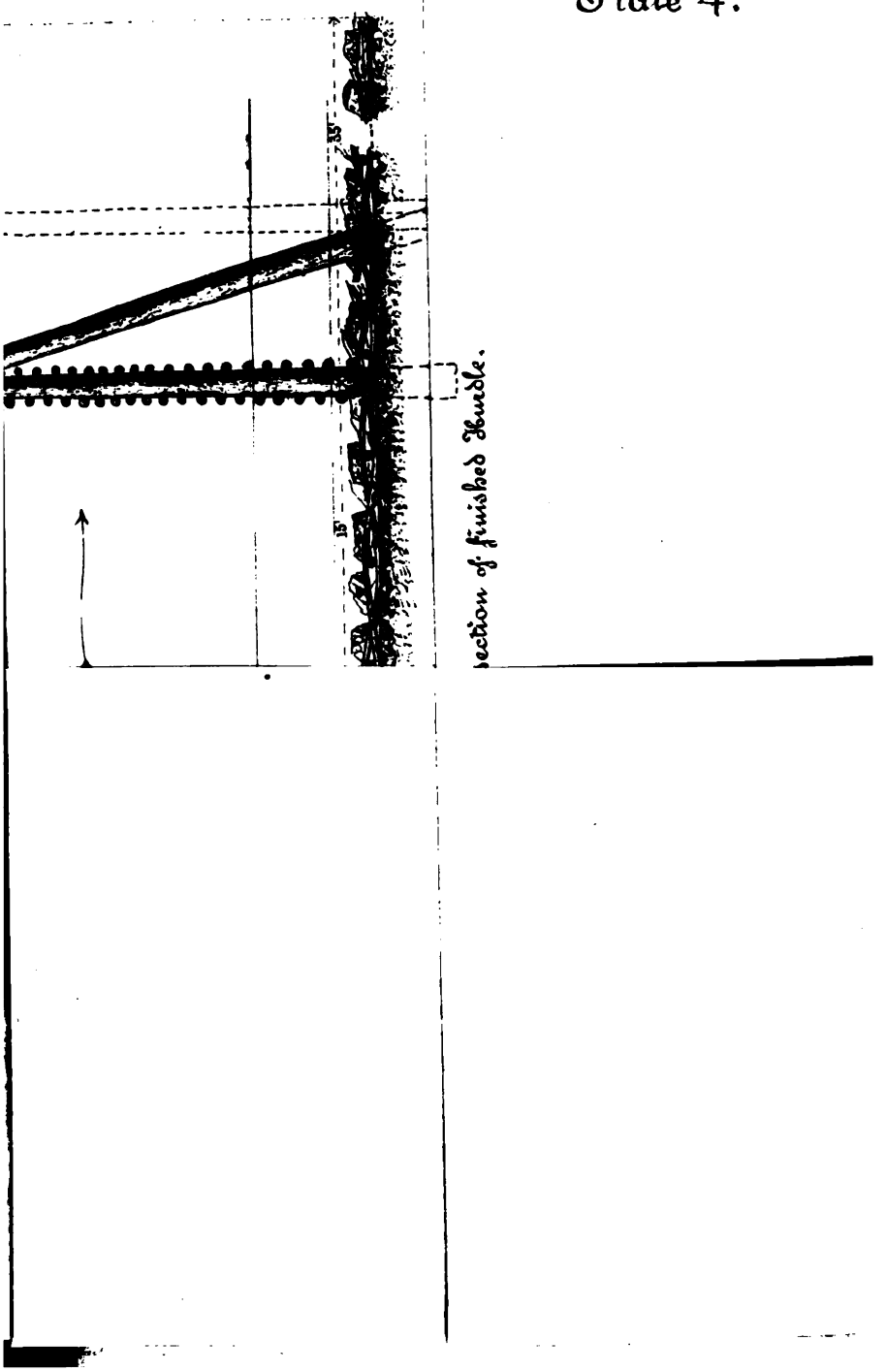


Plate 4.



Money statement.

uly 1, 1888, amount available		$95,658.37
mount appropriated by act of August 11, 1888		300,000.00
		395,658.37
uly 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$173,827.34	
uly 1, 1889, outstanding liabilities	17,980.74	
uly 1, 1889, amount covered by existing contracts	32,507.95	
		224,316.03
uly 1, 1889, balance available		171.342.34
Amount (estimated) required for completion of existing project		12,957,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received for furnishing piles, stone, manilla rope, wire, nails, spikes, and screw-bolts, opened January 5, 1889, by Major A. M. Miller, Corps of Engineers, St. Louis, Mo.

[Balance available, $270,000; total amount according to awards, $53,734.60.]

No	Name and address of bidder.	Piles.						19,000 cu. yds. stone.		37,000 pounds manilla rope.		22,000 pounds wire.		26,000 pounds nails.		21,500 lbs. spikes.		15,000 screw-bolts.		Total.
		2,000, 30 to 35 ft., 65,000 ft., per ft.	5,000, 36 to 40 ft., 190,000 ft., per ft.	4,000, 41 to 45 ft., 172,000 ft., per ft.	3,000, 46 to 50 ft., 144,000 ft. per ft.	1,000, 51 to 60 ft., 55,500 ft., per ft.	Amount.	Per cubic yard.	Amount.	Per pound.	Amount.	Per pound.	Amount.	Per pound.	Amount.	Per pound.	Amount.	Per pound.	Amount.	
		Cts.	*Cts.*	*Cts.*	*Cts.*	*Cts.*		*Cents.*		*Cents.*		*Cents.*		*Cents.*		*Cts.*		*Cents.*		
1	W. H. B. Stout and J. S. Holle, Lincoln, Nebr*	6⅔	7⅔	8	8⅔	10	$51,022.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	$51,022.50
2	Nathan W. Tucker, Parkersburgh, W. Va.	†5	†5⅔	†6	†6⅔	†7	37,265.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	37,265.00
3	John Cleary, Chester, Ill	7	8	9	10	11	55,735.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	55,735.00
4	Albert Bussen, Oakville, Mo	.....	.....	.....	.....	.....	.....	57½	$10,925	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,925.00
5	Ludlow Saylor Wire Company, Charles L. Dean, treasurer, St. Louis, Mo.*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	{3.1 / 3.4}	$715.00	.....	.....	.....	.....	.....	.....	715.00
6	Thomas S. Maxwell, St. Louis, Mo	.....	.....	.....	.....	.....	.....	.....	.....	{14⅜ / 14½}	$5,292.50	.....	.....	.....	.....	.....	.....	.....	.....	5,292.50
7	William C. Wilkinson, St. Louis, Mo	8½	9	9½	10	11	59,479.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	59,479.00
8	John W. Reno, Hayward, Mo	8⅝	8½	8⅝	8½	8½	53,252.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	53,252.50
9	Jefferson Iron Works, Steubenville, Ohio	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	{1.97 / 2.07}	$522.20	2.72	$584.80	.....	.....	1,107.00
10	Harry E. Coffin, Memphis, Tenn	.....	.....	.....	.....	.....	.....	.....	.....	14	5,180.00	†3	660.00	.....	.....	2.76	593.40	†2.33	$2,097.00	8,530.40
11	Daniel Kerwin, St. Louis, Mo	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.50	2,250.00	2,250.00
12	George F. Ernst, St. Louis, Mo	7⅞	8½	9	9 9/10	10½	56,137.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	56,137.25
13	H. L. Fox & Co., St. Louis, Mo	.....	.....	.....	.....	.....	.....	.....	.....	†13 1/10	5,032.00	3.2	704.00	†1.94	504.40	†2.68	576.20	2.49	2,241.00	9,057.60
14	St. Louis Bolt, Bridge, and Forge Works, Silas De Main, secretary, St. Louis, Mo	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2⅛	2,099.70	2,099.70
15	William J. Breslin, St. Louis, Mo.‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2⅜	591.25	2.4	2,160.00	2,751.25
16	Grafton Quarry Company, J. S. Roper, secretary, St. Louis, Mo.§	.....	.....	.....	.....	.....	.....	140	7,600	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,600.00
17	James J. Hawk, St. Louis, Mo	.....	.....	.....	.....	.....	.....	.....	.....	12⅜	5,133.75	3.2	704.00	.....	.....	.....	.....	.....	.....	5,837.75
18	Louis Grund, St. Louis, Mo.¶	.....	.....	.....	.....	.....	.....	55	10,450	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,450.00
19	William H. Langdale, St. Louis, Mo.‖	.....	.....	.....	.....	.....	.....	.....	.....	14 ¼	5,254.00	.....	.....	.....	.....	.....	.....	.....	.....	5,254.00
20	M. B. Teague, St. Louis, Mo.*	.....	.....	.....	.....	.....	.....	.....	.....	14 1	5,217.00	.....	.....	1.98	514.80	2.86	614.90	.....	.....	6,346.70
21	M. M. Buck & Co., St. Louis, Mo.‖	.....	.....	.....	.....	.....	.....	.....	.....	14.16	5,239.20	4⅜	962.50	1.99	517.40	2.725	585.87	2.4	2,160.00	9,464.97

* No guaranty.
† Contracts awarded.
‡ Guaranty to one copy only.
‖ Slight informalities in proposals.
§ Distance of quarry, 40 miles.
¶ Quarry at St. Louis.

Abstract of proposals for brush and poles opened February 18, 1889, *by Maj. A. M. Miller, Corps of Engineers, under notice of ten days by circular letter dated February* 8, 1889.

[Quantities: 18,500 cords brush and 1,500 cords poles. Balance available, $240,000.]

To whom circular was sent.	Name of bidder.	Per cord.		Amount.
		Brush.	Poles.	
John W. Reno	John W. Reno	$1.00	$2.00	$16,500
John Cleary	John Cleary	1.10	1.10	16,500
L. D. Thurman	L. D. Thurman	2.95	8.35	44,850
N. W. Tucker	N. W. Tucker	.95	1.47	15,030
R. F. Johnston				
Lawrence Evers				

Contract awarded to N. W. Tucker.

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

ST. LOUIS, MO., *June* 30, 1889.

MAJOR: I have the honor to respectfully submit the following report upon the improvement of the Mississippi River in this vicinity for the fiscal year ending June 30, 1889, and to accompany it with the reports of assistants in local charge, to which reference is made for details.

They are as follows: "Carroll's Island Hurdle" and "Pulltight," by Mr. William S. Mitchell; "Twin Hollows," "Jim Smith's," "Sulphur Springs," and "Procuring Brush," by Mr. C. D. Lamb; "Lucas," by Mr. J. O. Holman; "Plant and Supplies," by Mr. S. S. Van Norman.

1. CARROL'S ISLAND HURDLE.

Three gaps, aggregating 450 feet in length, were closed, the wattling repaired, and the revetment at the lower end of the line was extended.

2. TWIN HOLLOWS.

The lower part of the new bank was protected in 1886, and that work remained in good condition, but a cut had been made behind it a distance of 1,750 feet above hurdle No. 1.

This was partly repaired by placing a mattress upon 1,550 feet, and stone revetment upon 1,315 feet. The remainder awaits a favorable stage of the river.

3. PULLTIGHT.

In continuation of the project hurdles Nos. 1 and 2 were built from shore to the bar during the months of March, April, and May. They were broken about the last of May, when the river rose rapidly to the top of the hurdles. The wave subsided almost as rapidly as it came, and the repairs of the lines were begun when a favorable stage was reached. This work continued to the close of the year.

Hurdle No. 4 was repaired during August and September. Soon afterward the channel changed so as to follow the line of the hurdle closely. It scoured a portion of the piles from the upper row, which were replaced during the fall. This line was damaged again during the winter, and was repaired upon the resumption of work. The high water at the end of May made other breaches which have not been closed.

The channel has not crossed to Pulltight since hurdle No. 1 was built.

4. JIM SMITH'S.

Work was resumed about May 10 on the extension of hurdles from No. 6 to 7½ inclusive, in accordance with the amended project. The force, limited by the plant available, was small, but considerable progress had been made on Nos. 6 and 6½ when the work was suspended about the 5th of June, and the party was transferred to Pulltight.

5. SULPHUR SPRINGS.

The wattling of hurdle No. 16 was completed.

6. LUCAS.

Quarters were erected on shore during the winter, and, beginning in March, hurdles Nos. 1, 2, 3, and 4 were built.

Work done.

Location.	Aggregate length of hurdle lines, in feet.	Number of piles and braces driven.	Number of strings placed.	Mattress.		Wattling.		Revetment.	
				Linear feet.	Square feet.	Linear feet.	Square feet.	Linear feet.	Square feet.
Carroll's Island Hurdle*	450	102	26	.....	.....	553	5,184	90	1,917
Twin Hollows†	.....	.....	.....	1,578	85,400	.....	.....	1,815	30,050
Pulltight‡	4,665	4,376	983	6,758	414,730	4,780	76,734	700	65,996
Jim Smith's§	1,500	554	76	1,400	94,500	.....	.....	.....	.....
Sulphur Springs§	.....	.....	.....	.....	.....	1,400	13,400	.....	.....
Lucas§	7,170	3,548	781	7,820	471,600	7,030	116,915	485	15,325
Total	13,785	8,580	1,866	17,548	1,066,230	13,763	212,233	2,590	113,286

* Repairs of hurdles.
† Repairs of bank protection.
‡ Construction and repairs of hurdles.
§ Hurdles.

7. PROCURING MATERIAL.

Of the 9,302.85 cords of brush received, 4,467.5 cords were procured by hired labor, and the remainder by contract, delivered upon Government barges.

Piles were procured by contract, delivered at the works.

Stone was procured by contract, delivered upon Government barges, at Grafton, Ill.

Miscellaneous material, including bolts, iron, nails, rope, spikes, and wire, were purchased by contract, delivered at the supply depot.

The steamer *Gen'l Gillmore* did the towing, delivered supplies, and moved the plant as required.

8. PLANT.

The steamer *Gen'l Gillmore*, barges Nos. 25, 26, and 27, also pile-drivers Nos. 1, 2, 3, 4, 5, 7, 8, 11, 12, 15, 16, 17, 18, 19, and 20, received extensive repairs; other vessels ordinary repairs. Forty-two skiffs and twenty-five flats were built.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. WILLIAM S. MITCHELL, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1889.

MAJOR: I have the honor to report that the following repairs were made to the Carroll's Island hurdle during the year ending June 30, 1889, the hurdle being restored across gaps aggregating 450 feet in width.

The first gap was 200 feet in width, between points 850 and 1,050 feet east of the angle in the hurdle. The piling here had been completely broken down and removed by ice and drift.

The second gap was 150 feet wide between points 50 and 200 feet east of the angle. Here the hurdle had been destroyed by a fire which had left only the stumps, 3 or 4 feet long, of the piling.

The third gap began at the angle and extended down-stream 100 feet.

In the first and third breaks the water was deep enough to admit pile-drivers in restoring the line, but in the second it was too shoal and the new pile and braces were bolted to the stumps of the old work.

The wattling was restored across the breaks and thoroughly repaired along the entire length of the wall between the angle and Carroll's Island.

On the island, at the hurdle end, the bank was graded anew and the stone revetment repaired and restored.

The work was done between September 6 and 15.

Very respectfully, your obedient servant,

WILLIAM S. MITCHELL,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1889.

MAJOR: I have the honor to submit the following report of operations at Twin Hollows, west side, for the fiscal year ending June 30, 1889.

An examination of the protection work at this place made early in November showed that the work done in the fall of 1886 was all in good condition, but the unprotected bank had been cut away for a considerable distance inside the low-water mattress. This erosion begins at a point 700 feet above hurdle No. 0, where for 200 feet, measuring down-stream, the bank has been cut away above the 6-foot stage to a distance of about 75 feet inside the old work. For 200 feet below the lower end of this cut the erosion has been small, but its width gradually increases as we approach hurdle No. 0, where it amounts to 75 feet with a maximum depth of 6 feet inside the old work at a stage of 2 feet above standard low water. Below hurdle No. 0 for 70 feet the top of the bank has been cut away for a distance of 100 feet inside the old work. Between this bench and a point 160 feet below the hurdle a semicircular basin 80 feet wide and 15 feet deep has been excavated by an eddy during high water. For 50 feet below this basin the erosion has been very small, but its width increases as we go down-stream and amounts to 75 feet at the drift above hurdle No. 1, or 1,045 feet below hurdle No. 0.

This erosion made necessary the building of a medium stage mattress, which was begun November 20. This mattress was built on way-flats whenever they could be floated, and at other places the weaving poles were held up by forked sticks. It varied in width from 25 to 75 feet, and for convenience in building and placing it was fabricated in several sections.

One section was built on the bank in the cut mentioned, from 500 to 700 feet above hurdle No. 0, which extended from the old work to the top of the bank, except for 50 feet at its lower end, where, as the bank was exposed to a strong current during high water, all that portion above an 8-foot stage was covered with riprap. For 225 feet below this section the revetment was carried from the old work up to the top of the bank, but from a point 275 feet above hurdle No. 0 to 1,045 feet below the same line the bank was covered with a medium stage mattress from the old protection up to a stage of 6 feet above standard low water; below this point the bank has been eroded but little and seems well protected by heavy drift held by hurdle No. 1.

The fabrication of mattress was completed on the 3d, and its placing on the 11th of December.

Meanwhile the bank unprotected by mattress was being riprapped as fast as stone could be procured, and this work was continued until December 17, when work was suspended for the season and the plant towed into harbor. The revetment had then been completed up to the top of the bank to a point 765 feet below hurdle No. 0, 280 feet above the lower end of the medium stage mattress; below this point the water is so shoal that at no time after the mattress was sunk could a loaded stone barge be floated within 100 feet of the unprotected bank.

The total amount of work done during the season was as follows:

Medium stage mattress built and placed.....1,570 linear feet, or 85,400 square feet.
Revetment placed.....1,315 linear feet, or 30,050 square feet.

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. WILLIAM S. MITCHELL, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1889.

MAJOR: I have the honor to submit the following report of operations at Pulltight, Ill., during the fiscal year ending June 30, 1889.

During the fall season of 1888 work was confined to the repair of hurdle No. 4, which had been damaged during the high water of the preceding June.

Owing to the very deep water found near the old hurdle, the new work was constructed on a shoaler line, 300 feet above it, and connected with it at the ends.

Work was begun August 4 with four pile-drivers and a mattress gang, but the force was rapidly increased to eleven drivers and two mattress gangs, and by the end of the month all pile-driving and mattress-work was completed. On September 6 the wattling was completed and the force was transferred to Carroll's Island.

The new work was 1,750 feet in length. The upper or drift row was driven in clumps of three piles each, 10 feet apart, one pile in each clump reaching to the level of the 25-foot stage on St. Louis gauge; the other two reached only to the stringer which was placed at the level of the 20-foot stage. In those portions of the hurdle sloping back to the old work the clumps were 20 feet apart, with a single pile driven between them, bolted to the stringer and reaching to the 25-foot level. The hurdle row was driven 22 feet behind the clumps, with braces, stringers, and cross-stringers between the two rows in the ordinary manner. The mattress was of the usual type, 65 feet in width, and when sunk around the hurdle piles reached to the base of the clumps. As the water was too deep to wattle the piles, brush curtains were made and sunk in front of the hurdle row, extending from the bottom to the level of the 5-foot stage, and above them wattling was placed to the 12-foot level.

On the 1st of August there were two steam-boat channels past Pulltight and Twin Hollows, one marked by lights from hurdle No. 2, Pulltight, with deep water through the gap in hurdle No. 4, to the outer end of No. 5; thence over a wide bar, with a depth of 8½ feet at the 14-foot stage, to a light on the Missouri shore 1,000 feet below Whitehouse. The other channel, with slightly deeper water (9½ feet), was somewhat narrow and crooked, and was close to the Twin Hollows Bar crossing the reef near the outer end of hurdle No. 5, Twin Hollows. When work was begun to close the gap in Pulltight, hurdle No. 4, the first channel was abandoned, the second was lighted, and an effort was made by dredging with pile-driver jets to deepen and widen it for the use of steam-boats and with the hope that it might develop such a channel as to relieve the works at Pulltight, in part, of the great pressure of water pouring through the gap in No. 4. Four pile-drivers were placed on the bar at Twin Hollows August 9, and pulled themselves with anchors up and down over it for two days, using their jets constantly, and although the river fell during that time, they succeeded in slightly deepening the channel over the reef. They were then so much needed to increase the pile-driving force at Pulltight that they were removed.

During the low water of September the channel shifted back to the shore bar at Pulltight and crossed to the Missouri shore parallel with and immediately above Hurdle No. 4. This caused a scour along the front of the hurdle, which finally carried away the drift-piles for 580 feet at the outer end of the line. This was repaired under Mr. J. O. Holman, November 6 to 27. The drift-row was restored, not by clumps but piles driven 6 feet apart, each with its brace, and the latter reaching alternately to stringers placed at the 12-foot and 20 foot levels. Cross-stringers were also bolted to the top stringers and a few to the bottom stringer. The piling was protected from scour by a mattress 640 feet by 40 feet, extending 20 feet on either side of the drift-piles. At the east connection of the old and new hurdles the upper row of piles in clumps had been broken down for 150 feet by drift, and was replaced with a row of single piles and braces protected by a mattress 265 feet by 30 feet.

During the winter this hurdle was broken by ice about 150 feet east from the west angle. The gap was 150 feet wide in the hurdle-row and 250 feet in the drift-row. Work was begun March 12 to repair this, and the mattress being found intact no difficulty was had in re-establishing the hurdle-piles and in bracing and strengthening them. In front of this row, and to form a curtain for it and a mattress for the drift-row, a mattress 180 feet by 70 feet was constructed and sunk. The depth of water in the drift-line was so great that, on account of a scarcity of long piles, this row was then only partially restored, but it was completed in the early part of May.

On the 30th of May this hurdle was again broken in two places, each about 175 feet in width and beginning 200 feet and 175 feet, respectively, west from the east and west angles in this line. Between these gaps the drift-row was very much broken, but the hurdle-piles were in good condition. The damage was done by drift and high water which broke down hurdles Nos. 1 and 2. On the 28th of June two pile-drivers were placed on this line and began its repair. Others will be added as rapidly as they become available, and the hurdle will be fully restored.

It having been decided to extend hurdles Nos. 1 and 2 to the east limit of the 2,500-foot channel-way from the Missouri shore, work on No. 1 was begun March 22 on a

line parallel with the old hurdle and 570 feet below it. This necessitated revetting the bank between the two portions of the hurdle, but placed the new work on the line of the shoalest water in the vicinity. The extension is 1,640 feet in length and was completed May 9, with the exception of 150 feet of hurdle piles and braces at the west end of the line and which could not be placed on account of low water. The hurdle was constructed with a line of three-pile clumps for a drift row, a braced hurdle row with stringers and cross-stringers, and a mattress which extended to the base of clumps; it was curtained up to the 10-foot level and wattled 2 feet higher. While incomplete it was broken twice by scour and drift. The first break was repaired and a force was engaged on the second when, May 28 to 30, work was temporarily suspended on account of storms and high water. The river rose 8.5 feet in two days, reaching a stage 24.5 feet, submerging the hurdle and overflowing the adjacent banks. On May 31 the hurdle was broken in four places by the drift which had accumulated against it. The aggregate length of the gaps was about 700 feet, and the maximum depth of water formed in them was 46 feet, about 150 feet from shore. The great mass of drift above this hurdle was carried by the currents pouring through the gaps against hurdles Nos. 2 and 4, breaking them in succession.

As the water began to fall three pile-drivers were placed at work to repair the line, and the force was gradually increased to eight drivers, although on account of repairs to machinery they were not all continuously effective. The wreckage has been entirely cleared away and the piling has been restored across the gaps with exception of hurdle-piles and braces for about 300 feet, so that the line is practically unbroken for 1,500 feet from shore. Near the shore the drift accumulated so fast above the repairs that the drift line could not be kept straight, but was driven in a curve reaching down-stream nearly to the edge of the mattress. This necessitated widening the mattress 48 feet for 380 feet in length. A mattress 100 feet by 45 feet was constructed over the drift above the hurdle in this portion of the line and the whole was sunk to the bottom. A second mattress 150 feet by 50 feet was constructed over another portion of the drift farther out and it also will be sunk.

The extension of hurdle No. 2 was begun April 13, joining directly onto the old work and on a line parallel with No. 1, and on May 14 it was completed with curtains and wattling to the 12-foot level for 1,275 feet from shore. The drift clumps and mattress had been extended 100 feet farther, to the edge of the dry bar, beyond which nothing could be done at that time. The construction of this hurdle was similar to that of No. 1, except that the mattress was built immediately after driving the pile clumps, to the rear piles of which it was attached by yokes and which guided it into place while being sunk. About 180 feet of mattress had been made and sunk in that manner at the outer end of hurdle No. 1 before it was tried on No. 2. After sinking the mattress the hurdle-piles and braces were driven through it and the line was completed as rapidly as possible.

On May 13, the day after the completion of the wattling and three days after the first break in No. 1, this hurdle was broken also between points 550 feet and 675 feet from shore and directly in the line of the current through the gap in the upper hurdle. As the water rose with each new break in the No. 1, this gap widened until it reached 850 feet, beginning 130 feet from shore. Repairs were not begun until June 6, when a force of men and pile-drivers under Mr. C. D. Lamb were brought from Jim Smith's for that work. Four drivers were at first placed on the line, but others were added until June 21, when eight were in service; on the 28th and 29th three of these drivers were removed to hurdle No. 4, and at the end of the month and year the piling for the line was entirely restored except in 60 feet of the hurdle row about 500 feet from shore, and across which space a mattress was made and sunk on the last day of June. Piles for the drift row were driven for 200 feet beyond the point (1,275 feet from shore) at which the hurdle was stopped by low water, and the effort will be made at the present stage of the river to extend the hurdle to its full length—2,150 feet from shore. The mattress for the extension has just been begun. Wattling has not been attempted on either line.

The construction and repair of these hurdles has been difficult and slow, the river having made a most persistent and energetic effort to maintain its channel across their lines. The west channel, however, past Twin Hollows, is in use by steamboats and is a very good one, although not so deep as that passing this place and which we are endeavoring to close.

The protection of the bank between the two sections of hurdle No. 1 was accomplished with a mattress 640 feet in length and increasing in width from 50 feet to 100 feet and made from small willows cut on the bank. It was begun March 26 and was sunk April 3, and extends below the low-water contour from the slough below No. 1 to the extension of that hurdle. Above the mattress stone was placed up to the 18-foot level, and immediately above and below the hurdle end this stone work came up to the top of the bank at the 24-foot level. In addition to this, a line of piles was driven across the slough opening from the head of the mattress to the old hurdle, to catch drift and to stop the current which runs into the slough at the higher stages of the river.

The following statement shows the amount of work done during the year:

Number of piles driven		4,376
Stringers and cross-stringers placed		983
Foundation mattress constructed and sunk	square feet	410,230
Protection mattress constructed and sunk	do	50,095
Stone revetment placed	do	15,901
Curtains constructed and placed	do	44,500
Wattling placed	do	32,234
Mattress to sink drift constructed	do	12,100
Mattress to sink drift sunk	do	4,500

Very respectfully, your obedient servant,

WM. S. MITCHELL,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1889.

MAJOR: I have the honor to submit the following report of operations at Jim Smith's and Sulphur Springs for the fiscal year ending June 30, 1889:

The work done during the past year on the stretch of river between Beard's Island and the foot of Foster's Island was confined to completing and extending hurdles previously built, and for convenience it is all included in one report.

Operations were begun April 24 on Sulphur Springs hurdle, No. 16. This line, built in June, 1888, was found in good condition, and it had caused a fill of about 6 feet over most of the area protected by it. The hurdle was completed by raising the wattling from 12 to a 22-foot stage for 200 feet at the east end and to a 20-foot stage on the remainder of the hurdle. This work was completed May 8, and the force was then removed to Jim Smith's.

The hurdles at that place were found in good condition, but there has been a change there in the regimen of the river since the hurdles were built. The bar, which in 1884 prevented the completion of the lines below No. 3, now extends much farther toward the Missouri shore, but it has been cut through by a channel which runs down past the outer ends of all the lines below No. 6. A towhead, with its top from 20 to 25 feet above low water, has been formed from the head of the work to a distance of 2,000 feet below hurdle No. 7½, except in a chute from 200 to 300 feet wide below hurdle No. 5½. This towhead has been cut away for a distance of 50 feet inside the ends of No. 7 and No. 7½, but the water line at a 20-foot stage is about 100 feet outside the ends of Nos. 6 and 6½.

Work was begun May 9 upon the extension of hurdle No. 6½, and it was completed during the season, with the exception of the wattling, to a distance of 700 feet from shore. The drift row was driven and the mattress built to the outer end of the line 330 feet farther out, but on May 30 a rapid rise, accompanied by heavy drift began, which carried away 100 linear feet of floating mattress and overturned the unbraced drift piles. Two small breaks, each 50 feet wide, were also made in the completed line, one beginning 250 and the other 450 feet from shore. These breaks had been closed by a drift row when the pile-drivers were transferred to Pulltight on the 5th of June. The driving of piles on hurdle No. 6, which had been begun May 25, was suspended at the same time. It had then been driven and stiffened with stringers to a distance of 500 feet from shore. The mattress was built and placed to the same point and the force transferred to Pulltight on the 11th of June.

The usual form of construction was adopted on both lines, except that the mattress was built and placed before the hurdle-piles were driven, being held during construction by yokes woven into its upper edge which slipped down on the braces of the drift row. The stringers on the drift row of No. 6 were placed between the piles and braces, in order that the yokes might be used at higher stages.

The total amount of work done during the season was as follows:

Number of piles driven, 554.
Depth to which driven, 7,855 feet.
Number of stringers placed, 76.
Mattress fabricated, 1,500 linear feet, or 101,500 square feet.
Mattress sunk, 1,400 linear feet, or 94,500 square feet.
Wattling placed, 1,400 linear feet, or 13,400 square feet.

A survey was made June 11 to 13, and soundings taken from the head of Jim Smith's to the foot of Foster's Island.

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Major A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN O. HOLMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1889.

MAJOR: I have the honor to submit the following report of operations at Lucas' for the fiscal year ending June 30, 1889:

Construction work on the hurdles at Lucas' was begun March 6 and closed June 25. During that time four hurdles were built with a total length of 7,170 linear feet. The hurdles are numbered 1, 2, 3, and 4, with a distance of 1,000 feet between Nos. 1 and 2 and 2 and 3, and 1,500 feet between Nos. 3 and 4. The amount of work done on each hurdle is given in the following table:

	First hurdle.	Second hurdle.	Third hurdle.	Fourth hurdle.	Total.
Length of.....linear feet..	1,150	1,580	1,890	2,550	7,170
Piles driven.....number..	908	705	900	1,035	3,548
Depth driven.....feet..	11,211	8,459	11,660	13,641	44,971
Mattress.....linear feet..	1,870	1,660	1,950	2,340	7,820
Mattress.....square feet..	112,200	100,800	118,300	140,400	471,600
Wattling.....linear feet..	1,250	1,550	1,680	3,550	7,080
Wattling.....square feet..	29,125	28,000	28,540	30,950	116,915
Revetment.....linear feet..	260	80	80	65	485
Revetment.....square feet..	7,150	3,600	3,600	975	15,325

The form of construction was the same in all the hurdles. Two rows of piles were driven 22 feet apart, with the tops of the upstream or drift row left at the 25-foot stage and the lower or hurdle row at the 20-foot stage above low water. The piles in the drift-row were driven in clumps of two or three piles with the centers spaced 12 feet apart; the single line of piles in the hurdle row 6 feet apart. The three pile clumps were used in the drift-row nearly the full length of No. 1 and in the river ends of Nos. 2, 3, and 4. A double row of stringers were bolted to the drift-row piles, one at the 25-foot stage and one at the water surface, which averaged about a 12-foot stage during the construction of Nos. 1, 2, 3, and the shore half of No. 4. On the river half of No. 4 the stage of water was too high to place the lower row.

After the mattress was sunk a stringer was bolted to the hurdle-piles at the 20-foot stage with cross stringers reaching from the drift to the hurdle-row at each joint in the upper drift-row stringer. Brace piles were also driven below the hurdle row every 12 feet and bolted to the hurdle-stringer.

Seven pile-drivers were used on the construction work during most of the season.

The brush mattress was woven in the usual way. It was built 60 feet in width, 15 feet above the hurdle row, and 45 feet below it. For a length of 60 feet at the shore-ends of Nos. 2 and 3, the mattress was made 80 feet in width. For the protection of the shore-ends riprap was placed above the mattress to the top of the bank. A T-head mattress 100 feet long by 60 feet in width was placed at the river ends of Nos. 1, 2, and 3, with the upper end 55 feet above the line of the hurdle piles.

Wattling was placed the full length of each hurdle. At the shore-ends where the water was less than 10 feet in depth the brush was woven on the hurdle piles and pushed down with hurdling forks. In greater depths curtain mattresses averaging 125 feet in length were made between the drift and hurdle rows and lowered into place against the hurdle piles. The wattling on Nos. 1, 2, and 3 was placed to the 15-foot stage, on No. 4 to the 8-foot stage above low water.

Considerable difficulty was experienced in checking a scour which developed under the mattress near the shore-ends of Nos. 1 and 2. During the high water at the close of March, 400 linear feet of No. 1 hurdle gave way where weakened by this scour. At the same time nearly 100 feet was carried away from the river end of the hurdle. In repairing the break a mattress 230 feet long was placed along the shore just above the old drift row with rip-rap above to the top of the bank. Another mattress 260

feet long was placed across the shore-end of the break with its down-stream edge just above the line of the old drift row. The line of the drift and hurdle rows driven to close this break was slightly inclined up stream. The river-end of No. 1 was not re-driven.

The maximum number of persons employed at any one time was 250, all of whom were subsisted at the quarters on shore erected during the months of January and February. A tramway 450 feet long, extending from the quarters to the steam-boat landing, was placed on the hurdle to facilitate the handling of supplies.

Very respectfully, your obedient servant,

JOHN O. HOLMAN,
Superintendent.

Major A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. S. S. VAN NORMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1889.

MAJOR: I have the honor to submit my report of operations at the engineer supply depot connected with works of improvement under your charge, for the fiscal year ending June 30, 1889.

Following is a general account of work done on each class of plant under supervision of the superintendent of supplies:

TOW-BOAT.

New decking was placed on the main deck of the steamer *General Gillmore*, from the engine room forward, and on both guards.

The chocks, caps, and nosing of forward guards were renewed.

Seven kevels and 7 fenders were made, 2 braces for support of boiler deck, guard and bumpers on each outside rudder renewed, and the starboard fantail renewed.

The coal-boxes were sheathed and relined on the sides; the ice-box sheathed with galvanized iron, and the bed-plates under the main and nigger boilers, hatch-coverings, outriggers, plates for heels of fore and aft chains, renewed.

The brick-work in the ash-pan and around the boilers, and scuppers on the boiler deck, were renewed.

Iron knees were placed on the sides of forward guards; the forward guards sheathed; bunkers on sides of boilers rebuilt, and the splash bulkhead and hood end-plank, on both sides of hull at the false transom, sheathed with galvanized iron.

Only the principal items of repairs are mentioned, the almost innumerable minor repairs incidental to tearing up the deck of a vessel being omitted.

PILE-DRIVERS.

New leads were placed, one each on Nos. 4, 8, and 16, and two each on Nos. 15, 18, 19, and 20.

New crab-frames were made for Nos. 4, 11, 17, 18, 19, and 20, and new strainers placed on Nos. 1, 4, 5, 11, 12, 16, and 18.

New roofs were placed on Nos. 1, 4, 7, 8, 16, and 20, and new sills, one on No. 4 and two each on Nos. 3 and 20.

In addition to the above-named extraordinary repairs, the following ordinary work was done on all the drivers as needed: Replacing chocks, timber-heads, corner-bands, kevels, braces to leads, patching decks, calking, and general overhauling of machinery.

MACHINE SHOP.

Was calked once on the sides and ends.

BARGES.

The following extensive repairs were made to Nos. 25, 26, and 27.

A deck and frame, consisting of decking, beams, cutting-strake, plank-sheer, 2 sets of bits, 4 chocks, 6 sets timber-heads, 4 kevels, and nosing were renewed on each.

Four hatch covers were made for each and the deck and sides calked and new pumps supplied.

Extensive repairs to the sides of these barges, consisting of renewal of planking, were also made.

Four hundred feet of planking was renewed on barge No. 6.

New gas-pipe pumps were placed on barges Nos. 4, 5, 8, and 21.

Aside from the extensive repairs noted, the repairs to barges have been of an ordinary character, such as renewing timber-heads, chocks, and kevels; repairing pumps and capstans; patching and calking decks and sides and painting and lettering sides.

BARGE FLATS.

Nos. 57 and 58 were calked three times, 2 feet above light water line.

QUARTER-BOATS.

No. 5 was twice calked and a partition bulkhead renewed. No. 7 was calked twice and plank-sheer nosing, outriggers, and deck on the after end of the starboad guard renewed.

MATTRESS BARGE.

Ways and platform were removed to make a gangway on the barge, which is used as a wharf-boat, the deck sheathed and the heel of bitts fastened.

WAYS FOR MATTRESSES.

Forty-two were placed on small flats and 15 on large flats.

FLATS.

Seventeen small flats, 10 feet by 30 feet, and 8 barge flats 16 feet by 40 feet (decked) were built and 91 repaired, 37 of which were decked and platform decks built on 21.

SKIFFS.

Thirteen were repaired, 5 rebuilt at the depot, and 42 built under contract.

YAWLS.

Twenty-four were repaired.

TOOLS AND APPLIANCES.

Fifty-three cant-hook handles, 86 capstan bars, 8 pump brakes, 3 box and 18 gas-pipe pumps, 1 umbrella staff, and 10 coal-boxes were made. Handles were fitted to 20 pike poles, 72 axes, 62 cant-hooks, 35 hurdling forks, 3 hammers and 3 spike mauls, and 33 blocks were repaired.

Two hundred ring bolts, bolts for pile drivers, barges, and small boats, and numerous other appliances, were made at the depot and sent to the works during the year.

All tools and appliances and boarding outfit in the field requiring repairs were sent to the depot for that purpose.

PORTABLE BUILDING.

The roofs of ten sections were removed and painted. The office quarters on barge flat No. 57 were repaired by renewing the canvas on the roofs of 3 sections, covering the ends and sides of office with canvas, sheathing office floor, painting inside, and placing ventilators in each section.

BOARDING OUTFIT.

Seven refrigerators were made and 6 ice-boxes repaired. Fourteen water-cooler boxes and 3 meat-saw handles were made, 2 single bunks repaired, and 5 double bunks nailed together.

SUPPLY DEPOT.

A gangway to the wharf was built, the office floor sheathed, a coal shed, shed for bolts, and a shed for storing barrows and trucks were built, and roofs of buildings patched.

All subsistence supplies required in the field were also distributed from the depot.

Very respectfully, your obedient servant,

S. S. VAN NORMAN,
Superintendent.

Major A. M. MILLER,
Corps of Engineers U. S. A.

Construction account, showing total cost of works to June 30, 1889.

Name of work.	Expended prior to July 1, 1888.	Expended during fiscal year ending June 30, 1889.	Total cost to June 30, 1889.
Piasa Island:			
Dam	$32,333.30		$32,333.30
Dam (cutting channel)	3,116.86		3,116.86
Alton Dam	33,740.05		33,740.05
Alton Dike	76,652.74		76,652.74
Sawyer Bend protection	96,803.63		96,803.63
Venice Dikes	36,341.85		36,341.85
Arsenal Island protection	42,599.06		42,599.06
Closing Cahokia Chute	119,958.21		119,958.21
Channel opposite St. Louis	58,455.54		58,455.54
Horsetail Bar:			
Dike 1	40,549.53		40,549.53
Dike 2	23,600.26		23,600.26
Dike 3	82,692.54		82,692.54
Dike 4	41,290.11		41,290.11
Dike 5	36,933.87		36,933.87
Training-wall	81,253.28		81,253.28
Hurdles	548,834.08		548,834.08
Bank protection	40,903.55		40,903.55
Carroll's Island Hurdle		$4,093.58	4,093.58
Twin Hollows:			
West side, hurdles	248,837.82		248,837.82
West side, bank protection	19,161.31	7,817.65	26,978.96
East side, bank protection	128,920.30		128,920.30
Beard's Island:			
Primary hurdle	7,166.24		7,166.24
Bank protection	84,258.76		84,258.76
Jim Smith's, hurdles	327,983.44	14,079.66	342,013.10
Pulltight, hurdles	205,475.74	104,495.96	309,971.70
Chesley Island:			
Bank protection	64,416.04		64,416.04
Hurdles	27,808.61		27,808.61
Sulphur Springs, hurdles	177,964.24		177,964.24
Lucas', hurdles		67,427.60	67,427.60
Foster Island	44,296.02		44,296.02
Fort Chartres Dam	36,812.86		36,812.86
Turkey Island	24,463.85		24,463.85
Kaskaskia, protection	66,465.62		66,465.62
Liberty Island:			
Dam	5,053.91		5,053.91
Protection	45,129.40		45,129.40
Devil's Island:			
Dike 1	65,871.17		65,871.17
Dam 1	49,848.58		49,848.58
Dam 2	16,678.30		16,678.30
Minton Point, hurdles	33,436.37		33,436.37
Cape Girardeau, primary hurdle	31,930.18		31,930.18
Cairo, protection	160,439.82		160,439.82
Removing obstructions, snag-boat *Wright*	4,280.45		4,280.45
Total	3,272,797.49	197,914.45	3,470,711.94

Property and material account.

Class of property.	Balance July 1, 1888.	Debits.	Credits.	Balance June 30, 1889.
Steamer *A. A. Humphreys* (machinery)	$6,000.00			$6,000.00
Steamer *Gen. Gillmore*	14,286.80	$17,789.50	$18,675.61	13,400.69
Barges	49,772.19	10,910.83	18,264.32	42,418.70
Pile-drivers	33,426.62	5,311.68	11,118.47	27,619.83
Ways	1,318.31	226.86	653.66	891.51
Quarter-boats	1,405.44	368.31	868.31	905.44
Quarters	11,587.05	888.28	2,773.26	9,702.07
Supply depot	3,605.33	1,103.47	853.11	3,855.69
Machine shop	1,613.14	119.38		1,732.52
Small boats	4,630.64	11,297.43	6,527.30	9,400.77
Tools and appliances	1,974.05	2,292.06	1,770.92	2,495.19
Office furniture	410.47	100.00	87.99	422.48
Survey instruments	574.21	9.50	118.60	465.11
Photographic apparatus	200.48			200.48
Steamer *Gilbert's* machinery		142.80		142.80
Material:				
Brush	614.33	20,346.49	19,255.82	1,705.00
Piles	3,829.44	33,577.68	32,308.86	5,098.26
Stone	760.25	12,022.33	12,688.04	94.54
Stone, Little Rock	1,581.99			1,581.99
Manilla rope, etc	7,052.64	5,644.35	1,514.66	11,182.33
Wire	386.62	749.82	779.98	356.46
Iron	330.72	264.37	374.60	220.49
Nails	192.22	697.20	445.98	443.44
Spikes	304.44	732.08	750.08	286.44
Bolts, screws, etc	368.20	2,823.63	2,326.90	864.93
Clevises	122.93	.99		123.92
Lumber	416.50	6,461.90	6,299.51	578.89
Oakum	95.44	347.00	423.58	18.86
Coal	28.00	7,543.47	7,443.47	128.00
Ice		2,081.79	2,081.79	
Material, miscellaneous	446.57	4,962.60	4,023.47	1,385.70
Subsistence	394.36	19,612.04	19,874.88	131.52
Whisky and cinchona	1,385.98		220.98	1,165.00
Tug *Mignon*	4,077.72			4,077.72
Lost property	43,078.85			43,078.85
Profit and loss	24,148.84			24,148.84
Tents	190.75			190.75
Boarding outfit	11,055.41	1,475.23	2,342.56	10,188.08
Total	231,666.93	169,903.07	174,866.71	226,703.29

Detail construction account, showing cost of works during the fiscal year ending June 30, 1889.

Labor, material, plant, etc.	Carroll's Island hurdle.	Twin Hol. west-side bank protection.	Pulltight hurdle.	Jim Smith's and Sulphur Springs hurdles.	Lucas' hurdles.
Labor, superintendence, etc.	$891.13	$1,233.68	$27,377.96	$4,105.97	$20,102.45
General expense	151.67	261.11	2,751.48	691.20	1,641.78
United States Engineer office	296.74	510.88	4,548.36	875.20	2,077.57
Gauge readers	8.37	14.25	183.48	29.60	70.70
Telephone	69.24	119.20	1,051.22	198.40	471.00
Steamer *General Gillmore*	454.36	356.12	3,337.49	357.39	1,406.59
Barges	176.81		2,348.57	282.24	107.52
Pile-drivers	204.40		7,357.53	451.35	3,105.19
Quarter-boats	54.79	128.44	459.98	119.51	
Quarters	137.15		1,301.86	108.29	641.72
Ways for mattress					653.66
Supply depot	28.96	49.86	456.78	92.80	218.91
Small boats	91.08	92.83	2,946.68	552.12	2,729.26
Tools and appliances	31.35	78.57	993.33	59.78	404.61
Boarding outfit	86.38	92.59	1,111.57	255.20	585.62
Office furniture	2.77	4.78	44.02	9.04	21.52
Survey instruments	3.87	6.67	60.05	11.76	28.10
Subsistence	479.80	514.62	9,039.34	1,114.37	5,999.94
Whisky and cinchona			132.60		59.65
Brush	139.95	1,632.75	9,316.01	1,458.96	6,708.15
Piles	522.72		19,670.41	1,521.28	10,574.55
Stone	169.70	2,273.44	4,677.32	737.92	4,829.66
Rope		30.50	765.40	229.60	333.62
Wire	4.72	32.00	434.53	32.95	275.78
Nails		22.73	104.95	29.25	105.32
Spikes		11.82	305.20	73.00	253.20
Screw-bolts	15.32		1,043.24	159.79	1,028.09
Lumber		11.01	64.22	22.36	452.20
Oakum			7.21	3.77	
Coal	30.80	33.27	690.69	285.75	1,387.40
Ice	28.50		1,013.59	121.90	507.57
Miscellaneous material	13.00	6.04	540.89	88.91	646.27
Steamer *Eckert*, pumping out reef		300.50			
Total	4,093.58	7,817.65	104,495.96	14,079.66	67,427.60

A.—*Record of gauge at Grafton, Ill., and Gray's Point, Mo., for fiscal year ending June 30, 1889.*

[Height of water above plane 200 feet below St. Louis City directrix.]

GRAFTON, ILL.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	205.22	198.42	196.07	192.61	192.27	192.68	192.72	193.12	196.70	196.69	196.37	204.37
2	204.76	197.93	195.76	192.57	192.29	192.62	192.39	192.92	196.88	196.80	195.39	202.84
3	204.22	197.56	195.44	192.52	192.32	192.57	192.12	193.62	197.12	197.08	195.09	201.42
4	203.71	197.26	195.13	192.52	192.37	192.54	191.86	193.73	197.23	197.46	194.94	199.71
5	203.10	197.02	194.90	192.58	192.40	192.52	191.72	193.90	197.04	197.36	194.75	198.72
6	202.72	197.22	194.68	192.60	192.57	192.52	191.66	194.00	196.68	197.24	194.62	198.07
7	202.68	197.67	194.41	192.55	192.90	192.43	191.66	193.49	196.65	197.10	194.45	197.66
8	202.57	197.32	194.19	192.46	193.37	192.40	191.82	193.12	196.92	196.95	194.35	197.69
9	203.02	196.92	194.03	192.40	193.54	192.26	192.32	192.62	196.70	196.82	194.35	198.98
10	203.72	196.68	193.89	192.32	193.72	192.34	192.52	192.32	196.45	196.61	194.38	201.46
11	204.92	196.46	193.68	192.22	193.83	192.32	192.47	192.40	196.20	196.42	194.44	202.26
12	205.22	196.32	193.56	192.26	194.00	192.30	192.33	192.52	196.10	196.22	194.57	201.52
13	204.52	196.29	193.42	192.26	194.00	192.27	192.10	192.51	196.14	195.97	194.71	201.30
14	204.16	196.44	193.33	192.18	194.05	192.24	191.90	192.47	196.42	196.64	194.77	199.47
15	203.75	196.52	193.28	192.13	194.19	192.27	192.17	192.22	196.72	196.23	194.83	199.12
16	203.47	197.12	193.23	192.12	194.35	192.32	192.82	192.56	197.01	196.64	194.92	198.80
17	202.87	197.72	193.18	192.12	194.12	192.24	194.42	193.42	197.23	196.92	194.82	198.62
18	202.28	198.62	193.06	192.14	193.83	192.15	195.42	193.44	197.42	196.92	194.82	198.73
19	201.72	198.71	192.96	192.22	193.64	191.97	195.82	192.88	197.86	197.08	195.42	199.36
20	201.28	198.52	192.87	192.17	193.52	191.74	195.84	192.30	197.76	197.76	197.59	199.88
21	200.82	198.42	192.84	192.14	193.42	191.58	195.32	191.82	197.67	198.63	199.23	200.02
22	200.65	198.22	192.87	192.32	193.26	191.46	194.52	191.70	197.60	199.47	199.92	199.92
23	200.42	197.73	192.92	192.36	193.32	191.22	194.00	191.52	197.52	199.30	199.72	199.47
24	199.98	197.57	192.96	192.42	193.26	191.12	194.24	192.42	197.36	198.72	199.52	199.07
25	199.57	197.55	192.94	192.50	193.15	191.16	194.57	194.32	197.14	197.97	199.38	198.72
26	199.25	197.67	192.94	192.51	193.02	191.32	194.43	195.69	197.02	197.80	198.86	198.48
27	199.17	197.76	192.86	192.47	192.98	192.28	194.00	195.90	196.89	196.80	198.42	198.27
28	199.32	197.52	192.81	192.45	192.92	192.42	193.84	196.62	196.72	196.28	198.44	199.14
29	199.52	197.12	192.72	192.40	192.87	192.58	193.64	.....	196.58	195.97	199.02	197.95
30	199.46	196.65	192.65	192.32	192.76	192.96	193.59	.....	196.42	195.77	203.12	197.79
31	198.92	196.53	.....	192.27	.....	192.94	193.42	.....	196.50	.....	204.57	.....

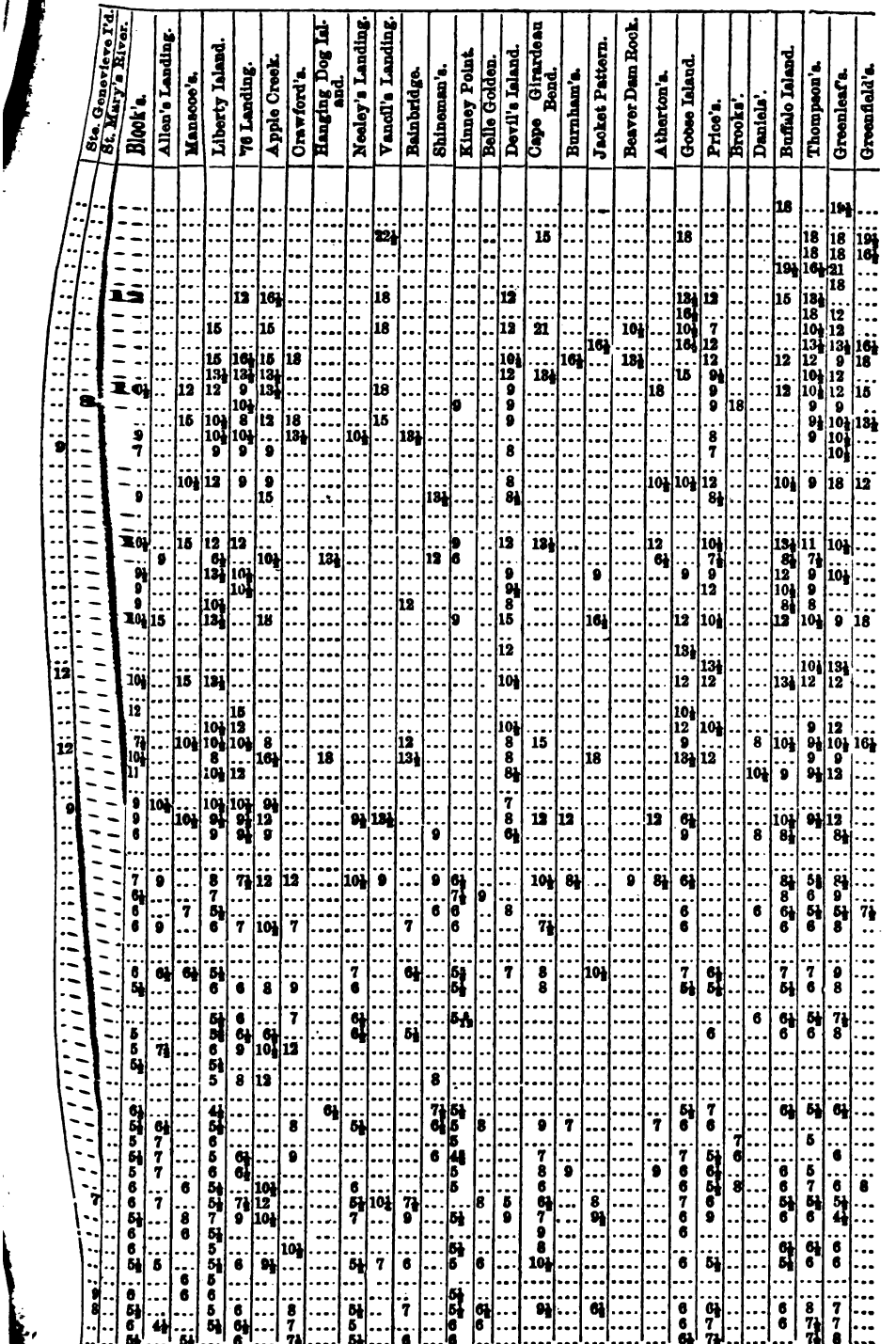
GRAY'S POINT, MO.

1	112.66	103.71	101.76	94.66	93.91	94.36	97.86	96.66	95.96	101.31	100.66	112.81
2	113.21	103.21	101.21	94.46	93.86	94.46	98.31	96.56	99.01	101.31	100.26	113.11
3	113.01	102.76	100.76	94.41	93.81	94.26	97.26	96.26	102.46	101.66	99.86	112.06
4	112.46	102.31	100.16	94.26	93.76	94.06	96.56	95.96	105.26	102.26	99.41	110.56
5	111.76	101.66	99.71	94.26	93.76	93.86	95.46	95.66	106.46	103.01	99.31	108.66
6	111.26	101.31	99.21	94.26	93.91	93.86	94.61	95.56	107.31	103.66	98.76	106.76
7	110.46	101.01	98.66	94.21	94.06	93.81	93.91	95.66	106.96	104.06	98.71	105.36
8	109.96	101.76	98.31	94.16	94.41	93.81	93.56	95.76	105.96	103.56	98.71	104.01
9	110.51	102.66	97.76	94.11	94.76	93.76	94.16	95.66	105.16	102.81	98.41	103.56
10	109.76	103.46	97.46	94.06	95.36	93.66	95.26	95.66	104.06	102.06	98.16	103.46
11	110.36	103.26	97.26	94.01	95.96	93.61	96.16	94.91	103.16	101.46	97.86	104.71
12	111.06	102.81	96.96	93.96	97.01	93.56	97.21	94.66	102.11	100.86	97.66	107.06
13	111.26	102.76	96.86	93.86	97.71	93.46	97.76	94.46	101.26	100.06	97.46	107.56
14	[illegible]06	103.46	96.66	93.76	97.76	93.36	97.46	94.36	100.91	100.16	97.51	106.86
15	[illegible]66	103.76	96.36	93.71	97.76	93.26	97.06	94.26	100.66	99.81	97.56	106.06
16	110.46	105.76	96.21	93.66	97.96	93.46	98.76	94.36	100.66	99.76	97.66	105.16
17	110.16	106.01	96.06	93.56	97.81	93.66	100.21	94.46	100.66	99.91	97.81	104.56
18	110.16	105.56	96.01	93.51	97.46	93.86	100.76	94.76	100.81	100.16	98.46	104.01
19	108.76	105.21	95.86	93.46	97.06	94.26	102.01	96.06	101.96	100.46	99.56	103.91
20	108.16	105.11	95.66	93.56	96.76	94.51	102.66	97.26	102.06	100.66	100.16	104.51
21	107.26	104.96	95.46	93.66	96.56	94.51	103.06	97.26	102.96	100.96	101.26	105.46
22	106.46	104.36	95.41	93.71	96.36	94.26	102.76	96.46	104.31	101.31	105.01	106.26
23	106.06	103.96	95.26	93.76	96.16	93.81	102.26	96.11	105.41	102.81	107.41	107.26
24	105.81	103.26	95.21	93.66	95.91	93.46	101.26	96.01	105.46	104.46	107.66	106.96
25	105.36	102.71	95.16	93.86	96.76	93.11	100.26	95.46	104.96	105.56	107.26	106.66
26	104.66	102.61	95.16	93.86	95.46	92.76	99.31	94.81	103.81	105.31	106.86	106.06
27	104.36	102.76	95.16	93.86	95.26	92.76	98.66	94.51	102.86	104.06	106.56	105.76
28	104.01	102.86	94.96	93.86	95.06	93.16	98.26	93.96	102.06	103.06	106.06	105.76
29	103.86	102.56	94.86	93.86	94.86	95.26	97.96	.....	101.56	101.96	105.76	106.01
30	104.06	102.26	94.76	93.91	94.71	96.86	97.46	.....	101.51	101.31	105.56	105.76
31	104.61	102.26	.....	93.96	.....	97.36	97.11	.....	101.46	.....	109.46	.....

B.—*Depth of water (in feet) upon*

Date.	Stage above standard low water by St. Louis.	Name of steamer furnishing report.	Direction.	Arsenal Island.	Quarantine.	Twin Hollows.	Pulltight.	Fine's Bluff.	Sulphur Springs.	Lucas'.	Cornice Island.	Selma.	Forest Home.	Perry's Towhead.	Salt Lake.	Brickey's.	Dickey Field.	Fort Chartres.	Turkey Island.	Crooke's.	Ste. Genevieve.
1888.	*Feet.*																				
July 5	20.9	City of St. Louis	Down	...	...	10½	...	...	...	...	...	...	18	13½	...	...	24	...	...	...	...
8	18.8	Arkansas City	..do ..	...	...	12	...	...	...	...	...	...	15	13½	...	...	...	...	...	...	...
11	21.3	City of Baton Rouge	..do ..	...	...	...	13½	...	...	...	...	...	15	15	...	...	18	...	...	...	...
11	21.3	City of Cairo	..do ..	...	...	...	...	...	...	...	...	...	18	9	...	16½	...	...	...	...	...
13	21	Belle Memphis	..do ..	...	...	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
17	19.6	City of Monroe	..do ..	...	...	19½	...	...	...	...	...	...	...	15	...	...	...	18	...	...	...
18	18.4	City of New Orleans	..do ..	...	...	...	...	...	...	9	...	...	15	12	...	...	...	...	...	10½	...
20	16.4	City of Providence	..do ..	...	...	12	...	...	...	...	...	...	13½	10½	...	...	16½	...	...	...	...
21	15.7	Oakland	..do ..	...	...	10½	...	...	...	...	...	...	12	9	...	...	13½	...	...	...	18
22	15	Arkansas City	..do ..	...	...	...	12	...	...	12	...	...	16½	10½	...	...	...	...	...	16½	...
25	13.6	City of Cairo	..do ..	...	...	10½	...	...	...	9½	...	...	10½	10½	...	...	...	10½	...	...	...
26	13.1	City of St. Louis	..do ..	...	...	9½	...	...	...	9	...	...	12	8	...	9½	...	13½	...	...	...
28	12.5	Sidney Dillon	..do ..	...	...	6½	...	...	...	8	...	...	12	9	...	...	9	...	...	...	9
31	12.4	Lily	..do ..	...	...	9	...	...	...	9	...	...	10½	9	...	...	13½	...	...	...	10½
Aug. 1	11.7	City of Baton Rouge	..do ..	...	...	7½	...	...	...	7½	...	...	12	8½	...	...	12	...	...	...	...
3	10.4	City of Providence	..do ..	12	...	...	8	...	...	7	...	...	...	8	...	...	10½	9	...	...	...
4	9.7	Arkansas City	..do ..	...	...	...	9	...	...	7	...	...	9	8	...	...	9	9	...	...	...
4	9.7	Gen. Gillmore	.....	...	16½	...	8	...	...	...	...	...	10½	...	...	...	...	...	...	...	...
5	9.2	Future City	Down	10½	...	...	...	...	...	8½	...	...	12	8½	...	...	...	...	...	...	16
7	9.2	City of Cairo	..do ..	12	...	9	...	...	...	8	...	...	10½	...	...	...	...	10½	...	...	12½
7	9.2	Gen. Gillmore	.....	...	...	7	...	...	6½	...	...	...	...	...	...	...	...	...	...	...	...
9	11.8	....do	.....	...	...	...	...	...	...	10½	...	...	13½	10½	...	...	...	12	...	...	...
10	11.8	City of New Orleans	Down	...	...	8½	...	...	...	8½	...	...	...	9½	...	12	...	9	...	...	...
11	10.9	City of Monroe	..do ..	...	...	...	6	...	...	6	...	...	...	5½	...	...	...	6½	...	...	9½
12	11	City of Vicksburg	..do ..	...	...	...	6½	...	...	8½	...	...	13½	8	...	...	...	10½	...	...	...
12	11	Belle Memphis	..do ..	10½	...	8	...	...	...	9½	...	...	...	8	...	...	...	...	...	...	...
12	11	Oakland	..do ..	16½	...	7½	...	...	...	...	...	...	...	7½	...	8	9	...	...	...	13½
14	11.3	City of Monroe	..do ..	...	...	...	...	...	...	16½	15	...	16½	9½	...	15	...	...	...	...	12
14	11.3	Gen. Gillmore	.....	...	...	8	...	...	16½	...	...	...	...	...	...	...	...	...	...	...	...
16	15.1	John Gillmore	Down	...	...	...	...	...	12	...	...	...	15	12	...	...	...	13½	...	...	...
17	14.3	City of Providence	..do ..	...	...	...	...	...	...	12	...	...	16	12	...	...	...	...	...	...	...
21	12.8	Port Eads	..do ..	...	...	10½	...	...	...	9	...	...	15	9½	...	...	...	...	...	...	...
22	12.1	Gen. Gillmore	.....	...	...	10½	...	...	18	...	...	...	...	...	...	...	...	...	...	...	...
23	11.4	Belle Memphis	Down	12	...	...	9	...	...	8	...	...	...	8½	...	...	...	...	...	...	...
26	10.4	City of Vicksburg	..do ..	...	...	8½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26	10.4	H. M. Hoxie	..do ..	9½	...	9½	...	...	...	9	...	...	12	8½	...	...	9½	...	...	...	9½
28	10.5	City of Monroe	..do ..	12	...	...	8½	...	...	9	...	...	13½	9	...	...	...	9	...	...	21
31	9.7	City of New Orleans	..do ..	...	...	7½	...	...	...	9	...	...	...	8	...	...	...	...	...	...	...
31	9.7	Gen. Gillmore	.....	...	...	8½	...	...	16	...	...	...	...	...	...	...	...	...	...	...	...
Sept. 1	8.7	Arkansas City	Down	...	...	...	7½	...	...	7	10½	...	...	7½	...	...	...	...	...	...	...
2	8.4	My Choice	..do ..	9½	...	7	...	...	...	7½	13½	...	12	8	...	7	9	...	...	...	...
5	6.5	City of Cairo	..do ..	10½	...	6½	...	...	...	8	...	...	...	6½	...	...	...	...	...	...	...
6	6.1	Gen. Gillmore	.....	...	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7	5.9	....do	.....	12	...	...	...	...	15½	...	...	...	...	...	...	...	...	...	...	...	...
7	5.9	My Choice	Down	9	...	5½	...	...	...	6	12	...	...	6	...	9	...	...	8½	...	10½
11	5.2	City of Vicksburg	..do ..	...	...	...	5½	...	...	5½	...	...	...	...	...	...	9	7	...	...	10½
12	4.8	.....	..do ..	...	...	5½	...	...	...	5½	13½	...	12	6	...	...	9	6	...	...	8½
12	4.8	City of Baton Rouge	..do ..	8	...	5½	...	...	...	6	12	...	8	...	...	...	...	6½	...	...	7
13	4.2	Gen. Gillmore	.....	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14	4.0	....do	.....	...	...	5	...	...	13	...	...	...	...	...	...	...	...	...	...	...	...
15	3.8	City of Providence	Down	6½	...	5½	...	...	...	5½	...	...	10½	5½	...	...	7	5½	...	...	8
15	3.8	Arkansas City	..do ..	7	...	...	4½	...	...	5½	...	...	9	5½	...	...	...	6	...	...	...
17	3.6	Gen. Gillmore	.....	...	...	4½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18	3.5	City of Cairo	Down	7	...	...	5½	...	...	5½	...	...	...	...	...	...	...	5	...	...	6½
19	3.2	City of New Orleans	..do ..	8	...	5	...	...	...	5½	...	7½	...	5½	...	5½	...	...	...	...	8
22	2.8	Gen. Gillmore	.....	8½	...	...	...	...	16	5	...	...	8	5½	...	...	...	6	...	...	7½
23	2.7	....do	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	...	...	7½
23	2.7	Jay Gould	Down	8	...	5	...	...	...	5½	...	...	8	5½	...	...	6½	5½	...	...	...
24	2.7	Gen. Gillmore	.....	7	...	7	...	...	15	6	...	...	8	6	...	...	...	...	...	...	...
26	2.6	City of Monroe	Down	7½	...	4½	...	...	...	7	...	...	...	6	...	...	...	6½	8	...	...
28	2.4	My Choice	..do ..	8	...	5½	...	...	...	6	...	...	8	5	...	...	...	5	...	...	7
Oct. 1	2	City of Providence	..do ..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	1.9	Arkansas City	..do ..	5	...	...	5	...	...	6½	...	...	...	5	...	...	...	5½	...	...	9
5	1.7	City of St. Louis	..do ..	7	...	5½	...	...	...	...	...	...	...	5½	...	...	5½	5½	...	...	9
6	1.7	Belle Memphis	..do ..	6	...	...	6	...	...	6½	...	...	...	5½	...	...	5½	5	6½	...	8
8	1.7	City of Baton Rouge	..do ..	6½	...	...	...	...	...	7	10½	...	7	5½	...	...	5½	5½	...	...	8½
11	1.4	New South	..do ..	8	...	9	...	...	...	...	...	...	9	8½	...	...	...	6	...	...	...
13	1.2	Hudson	..do ..	9	...	...	...	...	...	...	...	...	...	...	9	...	...	6	...	...	...
17	1.1	City of Monroe	..do ..	8	...	6	...	...	...	...	6½	...	...	...	...	5½	...	...	...	...	8½
18	1.1	My Choice	..do ..	5½	...	5½	...	...	10½	5½	6	...	7	6	6	...	...	...	...	...	8
23	1.3	Arkansas City	..do ..	5	...	...	...	...	...	...	9	...	6½	5½	6	...	...	...	...	...	...
24	1.3	City of St. Louis	..do ..	7	...	...	...	...	...	6	...	...	...	...	...	...	...	...	...	...	...
26	1.4	Sidney Dillon	..do ..	8	...	6½	...	9	...	6	...	...	7	5½	9	...	...	...	...	8	8
27	1.4	My Choice	..do ..	6½	...	9	...	...	12	8	...	...	8	5½	5½	...	...	...	...	...	8½
27	1.4	Belle Memphis	..do ..	7½	...	...	...	...	...	8	...	...	7½	5½	6	...	...	...	...	...	8½

the bars between St. Louis and Cairo.



B.—*Depth of water (in feet) upon the bars*

Date.	Stage above standard low water by St. Louis gauge.	Name of steamer furnishing report.	Direction.	Arsenal Island.	Horsetail.	Quarantine.	Twin Hollows.	Pililight.	Fine's Bluff.	Sulphur Springs.	Lucas's.	Cornice Island.	Selma.	Forest Home.	Perry's Towhead.	Salt Lake.	Brickey's.	Dickey Field.
1888.	*Feet.*																	
Nov. 2	1.4	Gen. Gillmore		7	12	9		7	9	12	8							
3	1.4	City of Monroe	Down	7			9				7	8½		10½	6½			
7	1.3	Gen. Gillmore		7		9		7	9	12								
10	2.6	do			13	12					8			10½	6½			
12	3.8	do		9	13½			9	12	15	10½			10½	10½			
16	5	do																
17	4.6	City of St. Louis	Down												7			
23	2.6	Gen. Gillmore		8½	12	10½		10½	12	13½								
23	2.6	City of Monroe	Down															
26	2.3	Mississippi	do	9			9				9			8	5½			9
30	1.6	Gen. Gillmore			12	10½		9	10½	12								
Dec. 1	1.5	City of Cairo	Down	8										8	6½			
5	1.1	City of Vicksburg	do				8							7	5½			
8	1	City of St. Louis	do	7											5½			
8	1	Gen. Gillmore		8	10½	8½		9	9	10½								
12	.8	do		9	10½	9		8½	9	10½								
22	.1	do		8	10½	9		8½	8½	10½								
24	.1	do		8½	10½	9		8½	9	10½								
27	.7	do			12						10½							
1889.																		
Mar. 7	11.4	Gen. Gillmore			18	18		18	16½	18								
12	10.3	do									12			9	10½			
16	6.6	do			18	13½		16½	13	18								
19	6.9	do			18	16½		16½	12	18	10½				9			
29	7.3	do			18	16		16	13½	18	10½			10½	10½			
Apr. 3	8.9	do			18	15		10½	15	18	10½			12	12			
9	8	City of Cairo	Down	8½							7				9	8½	7	9
12	6.4	Gen. Gillmore			16½	12		9		16	9			10½	10½			
14	5.8	Port Eads	Down	7			6½			10½	9			8	10½	10½		10½
16	6.1	Gen. Gillmore								13½								
17	6.5	do			16	12		8½	10½									
19	6.8	do									10½				12			
22	8.1	do			16			10½										
25	11.7	do								13	12				18			
27	9	do				12			12									
27	9	Belle Memphis	Down				10½		12		10½							
May 3	4.9	Gen. Gillmore			16			9		15	10½				9			
4	5.1	do				12			10½									
5	5	My Choice	Down	9			7½				8½	10½		10½	9½			8½
6	5.1	City of Monroe	do					10½			12			12	12			
6	5.1	City of Vicksburg	do	8			6½				7			9	10½			7
8	4.8	Belle Memphis	do	10½			10½				9½				12			
9	3.8	City of Monroe	do	9			7											
1	3.8	City of Baton Rouge	do	9½			7½			15	7			13½	10½			9
9	3.8	Gen. Gillmore									10½				10½			
11	3.9	do			15	12		8	10½	13								
12	3.8	Belle Memphis	Down	9			6				6½	8		9				
15	4.1	My Choice	do	8			7			13	7			8½	9			
15	4.1	City of New Orleans	do	9			7½				6½			8½	8½			
15	4.1	Gen. Gillmore		8		13		7½			7½							
16	4.4	do			12					7½								
18	6.3	City of Vicksburg	Down	10½				7½			8			8				9
20	8.1	Gen. Gillmore		12	19	15		12	13	18								
24	14.1	do									13½				15			
27	12.7	do		15	22	16		13	15	18								
28	12.3	Arkansas City	Down	15			12				13½							
29	12	City of Baton Rouge	do					13½			16½			16½				
June 4	15.6	Gen. Gillmore			23			14	14	18½								
5	13.4	do				19												
6	11.7	do									15							
11	14.8	Arkansas City	Down	18			15				15			15	16½			
11	14.8	Henry Lourey	do	9			15				16½			12	9½	13		
14	12.4	Gen. Gillmore						16½	18	22	18			15	16	13½		
15	11.4	do					12											
17	10.3	do		13½		18					13½			18	9½	6		
18	10.2	do						13½										
19	11.4	do							18½									
20	12.1	do			19		13½											
15	11.4	Belle Memphis	Down				16½	16½					16½					
23	14	Arkansas City	do				16½							18	15			16½
24	13.6	Gen. Gillmore																
25	12.9	do												15		13½		
26	12.5	do									13½				13½			
27	12.9	do					13½			18								
29	12.3	do		13½	16½	16½												

between St. Louis and Cairo—Continued.

Fort Chartres.	Turkey Island.	Mudd's Landing.	Crooks's.	Ste. Genevieve.	Ste. Genevieve I'd	St. Mary's River	Block's.	Allen's Landing.	Manoooe's.	Liberty Island.	76 Landing.	Crawford's.	Neeley's Landing.	Vancil's Landing.	Bainbridge.	Shineman's.	Kinney Point.	Belle Golden.	Devil's Island.	Cape Girardeau Bend.	Burnham's.	Jacket Pattern.	Atherton's.	Goose Island.	Price's.	Brook's.	Buffalo Island.	Thompson's.	Greenleaf's.	Greenfield's.
7	7½					6			5	6	6½		5		9		6½	6		9½	9			6		8				
7	9																													
9	10½																													
7	9			9			6½																	8						
													6																	
5½				7			6½		6½		7		6	8	8½		8	6½			6			5½			7½		13½	
																					6									
5	7						6½		5½	7½	6½		6		7		7	6		8	5½			7	9	8		8½	9	
5½			6				6		6	5½	8		5½				6	6			5½			6½		6		8	6½	
5							6½		6	5½	6		5½				6	6			5½	6		6½		6		9	6	
				22			10½			12																				
9	9						12			16½																				
9	9						13½			13½																				
9	9																													
	8			7	8		8		8½	8	9		8½			9	8½	7½						7½	7½		8	7½		
9	9						9																							
8½				8	10½																									
9	9						12			13½																				
15	12						13½			18																				
	12						10½																	9½			12	12		
8	9						12	13																						
8	9½	12					8½		9	9½	9		7½			9	10½	6½		16				7			9	8	6½	8½
10½	16½					13½		15		16½	16½		13½	16½		16½	13½	15						12		15		16½	16½	16½
	7½			9	10½		10½		9½	9			8½					8						7			9	8½	8	
13½							10½																	9						
8	9					8½		9		9	8½		7	9		9		7					9	7		9½		7½	7½	
7½	8			8½			8½	8½		8½	9		8½	9				8	8½	13½		9	8		10½		8½	9	9
8½	7						10½			9																				
				9			9		8	9			7				8							7½						
	7	12		9	8		9		8½	9	8½	9½	7			8½	8½	7½				9		7			9	8	7½	9
7	7½			9			8½		8½	9	8½		8	7½	8½		9	7½				9		7					8	12
	7						10½			10½																				
	9	9		9½			10½			10½	10½													9½		9½		9½	9	
13	12																													
10½	15						18																	13½	18		15	15		
12				18			15																	15	16½					
12½	16½						13½				18													13½		18				
	8			12			13		12	12	12		12			12	12	9½			13½			9				16½	16½	
							13½																							
				19½					18	17½																				
												16½												16½			12	16½		
																											13½	19½		
	19½		13½																											
							13½																							

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis during the years 1887 *and* 1888.

Articles.	Receipts.		Shipments.	
	1887.	1888.	1887.	1888.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Coal and coke	85,063	96,208	665	7,065
Cotton	2,906	2,423	9	.....
Grain	101,252	81,140	343,764	222,414
Iron and steel	78,305	23,417	12,288	4,482
Lumber	213,165	130,855	6,876	13,065
Merchandise	382,755	394,758	308,910	290,326
Total	866,945	728,810	671,517	547,372

Shipments down the river from landings between St. Louis and Cairo.

Articles.	1887.	1888.
	Tons.	*Tons.*
Flour, bran, and grain, etc	34,457	37,257

Two million two hundred and fifty-nine thousand six hundred and twelve tons of freight were transferred by ferries at St. Louis during the year ending June 30, 1889.

List of steam-power boats that arrived at St. Louis during the year 1888.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
A. C. Conn	77.0	20.0	7.0	69.56
A. J. Baker	142.0	24.6	5.0	268.94
Albert Lea	64.8	12.3	4.0	24.47
Albert S. Willis	153.1	26.5	3.6	132.99
Albina	(*)	(*)	(*)	(*)
Alert	115.0	19.0	3.0	100.00
Alice Brown	192.0	34.0	4.0	551.36
Annie P. Silver	208.6	40.7	8.8	1,199.53
Arkansas City	273.7	44.7	7.8	1,236.99
Arkansas Traveler	(*)	(*)	(*)	(*)
Bald Eagle	202.3	30.0	5.4	454.71
Bart E. Linehan	127.0	23.5	3.9	178.83
Belle Mac	111.0	22.0	3.3	107.68
Belle Memphis	267.0	42.7	7.6	1,222.89
Belle of Ottawa	64.4	9.3	2.5	10.61
Benton	197.0	33.0	5.0	394.08
Benton McMillin	196.6	33.0	5.5	465.76
Calhoun	230.0	36.0	5.4	631.74
Campbell	167.0	34.6	5.6	267.28
Centennial	295.1	41.6	7.5	1,112.26
Charles Brown	200.0	33.0	6.0	544.12
Charlie Clarke	131.0	23.6	4.3	147.69
Charlotte Boeckeler	140.0	29.4	4.1	143.48
Cherokee	216.4	33.9	5.4	631.20
City of Alma	110.0	20.0	4.0	96.07
City of Baton Rouge	290.0	48.0	8.7	1,602.96
City of Cairo	271.2	44.0	7.8	1,266.12
City of Florence	160.0	32.0	5.3	358.31
City of Monroe	275.0	45.0	8.0	1,038.25
City of New Orleans	260.0	48.0	8.5	1,598.23
City of Providence	272.1	44.5	7.8	1,302.81
City of St. Louis	300.0	49.0	8.8	1,614.02
City of Vicksburg	273.7	44.5	8.2	1,356.52

* Not known.

List of steam-power boats that arrived at St. Louis during the year 1868—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Clara	59.2	16.9	2.3	11.61
Crystal City	234.0	42.2	7.0	838.28
C. R. Suter	189.6	52.0	7.0	.....
Dacotah	262.0	43.3	5.5	956.96
Dan. Hine	135.5	24.6	3.3	100.61
Dan. Thayer	145.5	26.0	4.3	139.04
D. H. Pike	199.6	33.5	5.5	465.75
Dolphin	135.8	22.8	4.8	156.16
Dora	199.5	25.2	4.3	392.28
Eagle	155.6	24.8	4.2	231.30
E. A. Woodruff	230.0	48.0	6.0	640.29
Edith	101.0	24.0	3.1	69.59
Edna	102.0	21.5	4.7	80.35
Emma Etheridge	126.0	26.5	4.8	188.45
E. M. Norton	174.0	30.0	6.0	549.58
Experiment	106.5	16.2	3.0	62.35
Fred. Nellis	95.0	19.0	4.0	70.26
Future City	187.4	36.0	6.1	589.30
General Barnard	215.0	37.0	5.0	500.00
General Charles H. Tompkins	188.0	25.5	3.8	356.55
General D. H. Rucker	217.0	36.0	5.0	490.83
General Gillmore	140.0	28.0	4.0	125.00
General Meade	192.0	30.0	4.3	171.46
George Lyale	174.0	33.0	6.0	426.74
George W. Parker	(*)	(*)	(*)	(*)
Grand Republic	260.0	50.0	8.5	1,965.92
Harry Brown	210.0	49.6	6.0	772.15
Helena	194.0	33.0	4.5	352.31
Helen Mar	126.0	23.0	4.0	133.61
Helene Schulenberg	130.3	25.4	3.7	107.95
Henry Lowrey	209.6	35.2	5.3	646.79
H. F. Frisbie	169.4	32.2	5.8	270.45
H. M. Hoxie	213.2	34.3	5.6	632.30
Hudson	223.3	37.6	6.3	741.76
Imperial	89.3	19.0	4.8	68.08
Ione	(*)	(*)	(*)	(*)
Iron Age	176.0	38.0	5.5	385.91
Ironsides	154.0	30.0	6.4	282.80
Jack Frost	165.0	30.0	5.4	350.77
Jay Gould	186.8	30.4	6.0	446.25
Jennie Gilchrist	100.5	18.5	3.8	74.48
J. G. Chapman	141.0	28.0	4.0	146.95
J. G. Parke	140.0	28.0	4.0	180.00
Jim Watson	126.8	28.6	3.7	107.42
Joe Peters	177.2	34.4	4.8	525.99
John Bertram	180.0	34.0	5.0	390.49
John Gilbert	220.0	44.0	6.0	647.39
John Gilmore	183.9	34.6	6.0	503.69
John R. Hugo	127.0	20.0	3.0	136.88
John R. Meigs	172.0	38.0	5.0	330.00
J. N. Macomb	176.9	62.0	7.0	.....
Josephine	155.2	28.8	4.8	240.77
Judith	184.4	33.2	4.4	685.23
Lily	178.0	28.0	4.3	200.00
Little Eagle No. 2	120.7	19.2	3.9	82.65
Lizzie Gardner	124.5	21.0	3.6	70.54
Mab	122.0	20.5	4.8	83.36
Maggie Keaney	128.5	25.0	4.5	148.62
Mary M. Michael	148.3	26.3	4.4	234.34
Mary Morton	210.0	32.5	6.0	456.96
Matt. F. Allen	148.6	22.5	6.8	278.60
Mattie Belle	173.3	26.2	4.2	240.72
May Bryan	115.0	28.0	4.5	115.00
Mississippi	175.0	32.5	6.0	390.14
Mohawk Belle	99.8	17.2	7.0	97.86
My Choice	183.6	35.0	5.0	462.23
Nashotah	100.9	18.0	6.5	94.39
New Haven	126.1	24.4	3.4	92.64
New South	257.0	42.6	7.0	992.95
Niagara	96.0	17.6	7.2	99.41
Oakland	210.0	35.0	6.0	623.81
Parker	65.0	16.4	7.2	47.45
Pearl	238.2	23.5	4.1	149.95
Peoria Belle	70.3	12.6	4.4	31.07
Pilot	118.8	21.2	3.7	118.73
Pittsburgh	250.0	39.2	5.8	722.17
Polar Wave	146.0	25.7	5.0	159.94

*Not known.

List of steam-power boats that arrived at St. Louis during the year 1888—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Port Eads	197.8	33.3	6.0	894.26
Rocket	99.1	16.2	3.6	85.62
R. A. Speed	124.0	22.0	4.2	210.13
Robert Dodds	123.5	25.0	5.7	128.61
Saint Paul	200.0	36.3	6.2	833.52
S. D. Barlow	249.0	43.6	7.2	753.62
Sidney	221.3	35.5	8.5	617.65
Sidney Dillon	175.0	33.3	5.5	430.58
Spread Eagle	224.5	33.3	5.7	539.34
Success	130.0	22.0	3.0	67.09
T. F. Eckert	176.0	34.5	5.0	519.43
Unadilla	43.8	12.6	4.8	26.09
Vedette	118.2	23.3	3.7	125.44
Viola Parker	52.5	11.2	4.9	14.09
War Eagle	279.2	42.0	6.1	968.74
W. H. Cherry	169.6	32.0	5.2	388.67
W. F. Nisbet	200.0	35.0	6.1	578.86
William Stone	136.2	26.0	4.9	174.00
Wyoming	257.0	45.0	6.0	1,034.15

List of barges and scows that arrived at St. Louis during the year 1888.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Alabama	(*)	(*)	(*)	(*)
Alaska	(*)	(*)	(*)	(*)
Alex. Mitchell	240	37	5	368.29
Alf. Korte	(*)	(*)	(*)	(*)
Anchor Line No. 1	167.5	32.6	7.5	634.82
Anchor Line No. 2	167.5	32.8	7.5	692.19
Annie	120.6	18.3	5.6	101.64
Annie Spies	(*)	(*)	(*)	(*)
Argentine	124	19.6	2.8	53.97
Bellaire	(*)	(*)	(*)	(*)
Bessemer	200.7	34.4	6	835.86
Betsy	(*)	(*)	(*)	(*)
Boy Blue	200	28.8	8	414.69
Buttercup	(*)	(*)	(*)	(*)
Cape Girardeau Transportation Company Nos. 1 to 16, inclusive	(*)	(*)	(*)	(*)
Caroline	199.7	35.9	6.4	838.64
Catawba	(*)	(*)	(*)	(*)
Centennial	(*)	(*)	(*)	(*)
Charley Pierce	152.5	30.5	6	670.55
Chunk	(*)	(*)	(*)	(*)
Clara Monte	54.2	11.8	2.8	20.10
Conn, Nos. 1 and 2	(*)	(*)	(*)	(*)
Daisy	(*)	(*)	(*)	(*)
Dean Adams	(*)	(*)	(*)	(*)
Delia	(*)	(*)	(*)	(*)
Dolomite	154.4	26.8	5	172.49
Dot	(*)	(*)	(*)	(*)
Dove	(*)	(*)	(*)	(*)
Eagle	(*)	(*)	(*)	(*)
Eagle Sand Company Nos. 1 to 3, inclusive	(*)	(*)	(*)	(*)
Edna	(*)	(*)	(*)	(*)
Emma Wilson	(*)	(*)	(*)	(*)
Fannie	153.4	27.9	5	181.06
Garry	(*)	(*)	(*)	133.74
Georgia	(*)	(*)	(*)	(*)
George Lysle No. 22	(*)	(*)	(*)	(*)
Gilchrist No. 1	(*)	(*)	(*)	(*)
Grafton	(*)	(*)	(*)	(*)
Great Republic	296	50.5	8.2	2,275.17
Griffith & Adams Nos. 13, 14, 15	(*)	(*)	(*)	(*)
Harry	(*)	(*)	(*)	13.01
H. B. Smith	184	32.5	6	838.35
Henry Leyhe	(*)	(*)	(*)	(*)
Homer	152	25	5	144.82
Homestead	(*)	(*)	(*)	(*)
Illinois	238.4	37	7.2	1,220.91
Iron Mountain	210	37.6	6.7	875.51

*Not known.

List of barges and scows that arrived at St. Louis during the year 1888—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Ironsides No. 4	(*)	(*)	(*)	(*)
Jennie Flowerree	200	28.8	8	414.09
Jessie	152.4	27.4	5.4	188.73
Jessie Bowlin	224	34.6	8	568.71
J. M. Norton	(*)	(*)	(*)	(*)
John Bailey	(*)	(*)	(*)	(*)
John Boyd	111.1	24.8	4.1	78.11
John Caldwell	(*)	(*)	(*)	(*)
John Crossen	(*)	(*)	(*)	(*)
John Hugo No. 2	(*)	(*)	(*)	(*)
Jessie	152.4	27.6	5.4	197.78
Jessie	(*)	(*)	(*)	(*)
J. Walton, Nos. 320, 413, 440, 439, 447, 459, 502, 514, 518	(*)	(*)	(*)	(*)
Keokuk No. 1	140.6	29.4	3.5	98.58
Khedive	(*)	(*)	(*)	(*)
La Belle	(*)	(*)	(*)	(*)
La Salle	(*)	(*)	(*)	(*)
Lelia	154	27.9	5	192.62
Little Dan	(*)	(*)	(*)	(*)
Louisiana	(*)	(*)	(*)	(*)
Lula	(*)	(*)	(*)	(*)
Luak	(*)	(*)	(*)	(*)
Mack	(*)	(*)	(*)	(*)
Maggie Monks	212.4	28.8	8	443.52
Mary Monks	212	28.8	8	443.52
Martin Michael	146	24.2	4.2	118.07
Mattie Belle	(*)	(*)	(*)	(*)
McCormick No. 8	(*)	(*)	(*)	(*)
Metropolis	(*)	(*)	(*)	(*)
Midland	(*)	(*)	(*)	(*)
Milton	160.6	38.2	7.2	366.91
Monongahela	(*)	(*)	(*)	(*)
Moss	(*)	(*)	(*)	(*)
Nellie Peck	(*)	(*)	(*)	(*)
New St. Louis Sand Company Nos. 4 to 9, inclusive	(*)	(*)	(*)	(*)
New York	(*)	(*)	(*)	(*)
Occident	(*)	(*)	(*)	(*)
Ostrich	(*)	(*)	(*)	(*)
Peru	78	26.8	3	48.56
Philo	(*)	(*)	(*)	(*)
Pike No. 2	171.6	27.2	5.2	188.79
Polar Star	(*)	(*)	(*)	7.71
P. R. Behlen	200	28.8	8	412.42
P. S. D. No. 16	(*)	(*)	(*)	(*)
Rachel	169.6	34.8	6.4	399.50
Rover No. 1	165	28	6	474.62
Rover No. 2	165	28	6	215.74
Ruth	179.2	34.7	6.6	759.66
S. C. Baker	123.1	32.8	3.7	94.53
Scott	151.3	24.6	4.2	134.92
Sterling	(*)	(*)	(*)	(*)
St. James	152	27	5.4	194.81
St. Louis and Mississippi Valley Transportation Company—				
No. 16	209.4	40	8.6	1,271.75
No. 19	211.5	40.6	7.5	1,348.65
No. 20	201.2	35.6	8	1,011.18
No. 21	200.6	36	7.8	1,002.40
No. 22	200.5	36	7.8	9,015.91
No. 23	200	36	8	986.62
No. 24	200.5	35.2	7.3	1,018.84
No. 25	201.4	35.6	7.2	2,020.60
No. 26	203.5	36	7.6	1,060.79
No. 27	200.5	35.6	7.4	1,038.47
No. 29	201	35.6	7.6	1,021.19
No. 30	225.6	34.8	8	1,126.85
No. 32	234.6	34.8	8.2	1,130.69
No. 33	227	35	8.8	1,171.99
No. 34	226.6	34.8	8	1,135.15
No. 35	225.6	34.8	9	1,129.63
No. 36	225.6	34.8	8.2	1,166.34
No. 37	227	35	8.4	1,193.11
No. 38	229	36.5	8.3	1,197.31
No. 39	230	36.7	8.3	1,201.29
No. 40	226	36.6	8	1,110.48
No. 41	226	36.4	8.2	1,211.79
No. 42	226	36.2	8.3	1,192.14
No. 43	226	36.4	8.2	1,164.08
No. 45	210	40.4	8.2	1,287.81

* Not known.

List of barges and scows that arrived at St. Louis during the year 1888.—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage
	Feet.	*Feet.*	*Feet.*	
No. 46	224.	36.4	8.	1,181.26
No. 47	226.	37.	8.	1,189.72
No. 48	226.8	36.	8.	1,161.10
No. 50	210.	40.	6.	1,211.66
No. 52	228.	36.	8.2	1,177.15
No. 53	203.	40.6	6.	1,165.81
No. 57	225.	36.	7.6	1,248.54
No. 58	225.	36.3	7.6	1,248.54
No. 59	225.	36.3	5.7	1,197.39
No. 60	220.4	32.	7.7	1,146.31
No. 61	220.4	32.	7.7	1,154.62
No. 62	231.7	34.5	7.5	1,121.53
No. 63	222.1	34.6	7.5	1,093.56
No. 64	220.3	34.6	7.5	1,096.62
No. 65	219.6	34.7	7.4	1,096.56
No. 66	225.	36.3	5.3	1,107.39
No. 67	225.	36.3	6.2	1,146.05
No. 69	226.	36.6	6.6	1,133.53
No. 70	226.	36.6	6.8	1,164.15
No. 72	227.	36.6	6.6	1,171.60
No. 74	226.	36.	6.5	1,101.77
No. 75	226.6	36.3	6.7	1,137.19
No. 76	224.	36.4	6.4	1,113.47
No. 77	226.5	36.	6.6	1,123.93
No. 78	226.	36.6	6.8	1,151.66
No. 79	226.	36.	6.8	1,163.78
No. 80	227.7	36.2	6.8	1,144.13
No. 81	226.6	36.	6.6	1,118.74
No. 82	226.	36.	6.8	1,101.11
No. 83	226.	36.	6.6	1,105.29
No. 84	226.	36.	6.6	1,101.63
No. 85	226.4	36.	6.7	1,102.45
No. 86	225.5	36.	6.6	1,127.97
No. 87	226.	36.6	6.6	1,123.99
No. 88	226.	36.4	8.2	1,202.23
No. 89	227.7	36.4	8.	1,174.62
No. 90	216.7	36.	79	1,079.81
No. 91	202.7	35.	76	998.98
No. 92	216.8	36.	8.	1,154.49
No. 93	228	37.	8.2	1,218.76
No. 94	228	36.6	8.4	1,221.57
No. 95	228.4	37.	7.8	1,220.91
No. 96	227.7	37.	7.2	1,220.60
No. 97	225.5	36.5	8.1	1,186.64
No. 98	238.4	36.4	8.8	1,237.12
No. 99	226.	36.3	8.2	1,141.80
No. 100	228.6	36.6	9.	1,274.81
Swan	(*)	(*)	(*)	28.64
Swan	(*)	(*)	(*)	116.89
Upon	(*)	(*)	(*)	(*)
U. S. No. 1	(*)	(*)	(*)	(*)
U. S. No. 2	(*)	(*)	(*)	(*)
U. S. No. 3	(*)	(*)	(*)	(*)
U. S. No. 4	(*)	(*)	(*)	(*)
U. S. No. 5	(*)	(*)	(*)	(*)
U. S. No. 6	(*)	(*)	(*)	(*)
U. S. No. 37	(*)	(*)	(*)	(*)
Virginia	(*)	(*)	(*)	(*)
V. W. Flowerree	200.	28.8	8.	414.69
W. H. Brown's Sons, Nos. 23, 24, 32, 34, 35, 37, 29, 37, 38, 41, 42, 43, 44, 45	(*)	(*)	(*)	
W. H. Brown's Sons' scows, 132 in all, known by numbers	(*)	(*)	(*)	
W. J. Brookbank	(*)	(*)	(*)	
William Gordon	227.7	36.6	6.6	1,262.01
William J. Lemp, No. 1 to 14, inclusive	(*)	(*)	(*)	
William Towle	202.	35.6	5.2	248.15
Wood	(*)	(*)	(*)	128.10
Yantic	(*)	(*)	(*)	(*)

* Not known.

Y 3.

IMPROVEMENT OF GASCONADE RIVER, MISSOURI.

The improvement of this stream has consisted in the removal of obstructions to navigation in the shape of leaning timber, snags, stumps, etc., and the construction of low wing-dams, to facilitate the passage of boats over the shoals during low water.

The work was begun in 1880, and has been continued, when funds were available, up to the present time.

A personal inspection of this stream was made in April and it was found that the river was obstructed by snags and rocks, and the banks were encumbered with overhanging trees at numerous points. The dams and training-walls previously built at Round Island and Bock's Bar were found to be in good condition and accomplishing the results expected.

It was decided to confine the present season's work to removing the obstructions and leaning timber, and for that purpose the steamer *Pin Oak* was chartered at $32.50 per day and work was commenced on April 15 and continued until May 31, when it was completed.

The amount of work done was as follows:

Number of snags, stumps, etc., removed from channel	284
Number of trees cut down	401
Number of overhanging limbs cut off	141
Number of trees girdled	45
Number of rack-heaps removed	3
Number of miles of river improved	78

For details of this work I would refer to the report of my assistant, Mr. J. W. Beaman, which is forwarded herewith.

The work has been of great benefit to the navigation of the river, especially to the rafting interests which are quite large, and the river is now in fairly good navigable condition from its mouth to Arlington.

With the amount recommended to be appropriated for the fiscal year ending June 30, 1891, it is proposed to continue the removal of obstructions and to continue closing the side chutes, in order to concentrate the water in the main channel of the river.

The estimated cost of this improvement was $50.000, and the former appropriations are:

By act of—	
June 14, 1880	$5,000
March 3, 1881	10,000
August 2, 1882	10,000
July 5, 1884	5,000
August 5, 1886	7,500
August 11, 1888	5,000

Money statement.

July 1, 1888, amount available		$61.97
Amount appropriated by act of August 11, 1888		5,000.00
		5,061.97
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888		2,498.06
July 1, 1889, balance available		2,563.91
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		10,000.00

REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., *June* 30, 1889.

MAJOR: I have the honor to make the following report upon the improvement of the Gasconade River, Missouri, for the year ending June 30, 1889.

During the fiscal year now closing no work of any kind in the improvement of Gasconade River was done previous to the 15th of April, 1889.

Upon April 15 and 16 an examination of the river was made under your own immediate supervision and direction.

The steamer *Pin Oak*, which had previously been chartered for river improvement work, was utilized in this examination.

The river was found to be obstructed by snags and rocks, and the banks were encumbered with overhanging trees at numerous points.

The works of contraction at Round Island and Bock's Bar, constructed in the fall of 1887, were found to be in good condition and doing the work for which they were designed.

The examination covered 46 miles of river, from the mouth to Pointers Creek.

The work of removal of channel obstructions and overhanging trees from the river banks commenced April 15 and closed May 31. During this time the following work was done:

Snags, stumps, and trees removed	284
Trees felled	401
Overhanging limbs cut off	141
Trees girdled	45
Rack-heaps removed	3
Miles of river improved	78

The river was thereby put in excellent condition for steam-boat navigation whenever the stage of water will admit of the passage over the shoals.

In the above work the steamer *Pin Oak*, belonging to the Hermann Ferry and Packet Company, of Hermann, Mo., was employed. The steamer was fitted with steam capstan and her light draught, 12 inches, rendered her especially desirable for the service in which she was used. The officers and working force consisted of Captain August Wohlt, acting master, a time-keeper, engineer, fireman, cook, waiter, and six laborers. Credit is due Captain Wohlt for the intelligent and efficient service rendered.

It is to be hoped that in the future more liberal appropriations of money may be made for the improvement of the river, both for snagging operations and for the construction of contraction works at the shoals.

The works at Round Island and Bock's Bar, constructed in the fall of 1887, have accomplished the object for which they were designed.

Shoals 71, 59, 57, 53, and 49 should have similar works constructed in the order named.

The dam at Prior's Mill should be raised about 3 feet and there may be need of contraction works at Turnpike Ford. This can be determined after the construction of the dam at shoal No. 71.

I have the honor to be, very respectfully, your obedient servant,

J. W. BEAMAN,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Articles.	Year ending June 30, 1888.		Year ending June 30, 1889.	
	Quantity.	Value.	Quantity.	Value.
Shipments down the river:				
Wheat	57,212 bushels	$45,769.60	74,222½ bushels	$63,089.13
Corn	125 bushels	62.50	413 bushels	144.55
Barley	54 bushels	32.40	397½ bushels	238.50
Oats			67½ bushels	23.63
Hay	116 bales	116.00		
Hogs	135 head	1,687.50	820 head	9,020.00
Tobacco			6 hogsheads	360.00
Eggs			3 cases	604.00
Walnut lumber	5,400 feet	324.00	28,591 feet	1,143.64
Yellow-pine lumber	1,000,000 feet	12,000.00	550,000 feet	7,150.00
Railway ties	500,000	166,666.67	200,000	50,000.00
Cord wood	617½ cords	1,235.00	603½ cords	905.25
General merchandise	28 tons	714.00		1,085.61
Totals		228,607.67		133,964.31
Shipments up the river:				
Pine lumber	1,150 feet	45.00	19,428 feet	582.84
Flour	191 sacks	420.20	232 sacks	545.20
Salt	59 barrels	97.35	254 barrels	419.10
Nails	55 kegs	165.00	74 kegs	148.00
Bran and shipstuff			19,300 pounds	115.80
Farm machinery		365.00		2,430.00
General merchandise	8.3 tons	1,168.85		6,043.45
Totals		2,261.40		10,284.39

Total value of commerce of river, 1888 ..... $230,869.07
Total value of commerce of river, 1889 ..... 144,248.70

List of steam-power boats engaged in commerce on Gasconade River during the year ending June 30, 1889.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Pin Oak	95	17.5	2.2	43.05
Royal	86.6	24	3	44.82

Y 4.

IMPROVEMENT OF OSAGE RIVER, MISSOURI.

The project for the improvement of this stream has consisted in the removal of obstructions to navigation such as snags and leaning timber, the dredging of channels through shoal places, and the construction of cross and wing dams to concentrate the water over shoal places.

Work was begun on this improvement on July 26, and consisted in the extension and repair of dam and training-wall at Hoskins Shoal, in repairing dam at Moore's Flat, and in removing obstructions from 60 miles of the river. The work was continued in the fall until November 7, when the working party was disbanded and the plant and tools stored at Hermann.

The amount of work done was as follows: At Hoskins Shoal 1,126 lineal feet of cross-dam and training-wall were repaired by raising the crest 2 feet above the lowest point of the dam previous to repair; 110 feet of new dam was built, and the bank was protected for a distance

of 104 feet above and below dam; 667 cubic yards of rock were used in this work.

At Moore's Flat 25 cubic yards of riprap was taken from the old works and placed upon the cross-wall where it was lowest.

The obstructions removed were as follows:

Snags pulled	29
Trees felled	29
Rocks removed from channel	53
Miles of river improved	60

The details of the work are given in the report of Mr. J. W. Beaman, assistant engineer, forwarded herewith.

The readings of the gauge at Tuscumbia were kept up during the year.

This work has been of great benefit to the navigation of the river, rendering it safer and also enabling steamers to navigate at a lower stage of water than formerly.

With the funds available and the amount asked for fiscal year ending June 30, 1891, it is proposed to continue the removal of snags, etc., and to raise and repair the wing-dams already built, and if necessary, put in some new ones.

The former appropriations are:

By act of—	
March 3, 1871	$25,000
June 10, 1872	25,000
March 3, 1873	25,000
June 23, 1874	25,000
June 18, 1878	20,000
March 3, 1879	20,000
June 14, 1880	30,000
March 3, 1881	20,000
August 5, 1886	10,000
August 11, 1888	5,000

Money statement.

July 1, 1888, amount available		$4,155.48
Amount appropriated by act of August 11, 1888		5,000.00
		9,155.48
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$4,248.52	
July 1, 1889, outstanding liabilities	401.50	
		4,650.02
July 1, 1889, balance available		4,505.46
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		10,000.00

REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., *June* 30, 1889.

MAJOR: I have the honor to make the following report upon the improvement of the Osage River, Missouri.

In accordance with verbal instructions, preparations were made to begin work early in July at Hoskins Shoal, distant from the mouth of the Osage River 43 miles.

July 5, 6, and 7 were occupied in a preliminary examination at and in the immediate vicinity of the above shoal. Between July 7 and 23 all necessary plant was repaired or obtained by purchase and transferred to the mouth of the river below Osage City.

July 24 a small party was organized, and on the same day camp was broken up and a start up the river was made. The party poling the plant, consisting of an open flat-boat and two small quarter-boats, carrying tents, tools, etc., to the mouth of the Maries River, 5 miles in six hours, made too slow progress. At this point the steamer *Hurlbut* took the plant in tow and on the evening of July 25 after 24 hours towing we arrived at the head of Hoskins Shoal.

The work of repairing the cross-dam at this point was commenced July 26, and ended October 10. During this time the following work was done:

At the head of Hoskins Shoal:	
Linear feet of cross-dam repaired	750
Linear feet of training-wall repaired	376
Cubic yards riprap deposited on cross-wall	406
Cubic yards riprap deposited on training-wall	69
Near the foot of Hoskins Shoal:	
Linear feet of riprap stone dam built	110
Linear feet of bank above and below dam protected	104
Cubic yards of stone deposited in dam and on bank	192

Recapitulation.

Linear feet of old works repaired	1,126
Linear feet of new works built	214
Linear feet of old and new work	1,440
Cubic yards of rock used	667

The repair of cross-dam and training-wall consisted in raising their crests to a level about 2 feet above the lowest point of the dam previous to repair. The dam as repaired is about 16 feet wide at base, 6 feet wide at crest, and about 4 feet high above the bed of the stream below the dam.

The new dam is about 14 feet wide at base, 8 feet wide at crest, and 3 feet high above the lowest point of the closed channel-bed.

The only material used in the repair of the old works and in the construction of new was riprap stone.

The new dam was built across a side chute near the foot of Hoskins Island, on the left side of the main channel. For several years this chute has diverted a large part of the low-water flow, and has thus rendered the passage of this shoal one of the most troublesome to navigation.

October 12, camp was moved to Moore's Flat, and October 13 was occupied in placing rock upon the cross-dam at that place. About 25 cubic yards of riprap rock were taken from old works and placed upon the cross-wall where it was lowest. This completed the work of repair of dams.

In addition to the work of repair and construction of dams at the above points, snags and rocks were removed from the channel and overhanging trees were removed from the banks, and the river, as far as snags, rocks, and trees are concerned, was put in good navigable condition as far up as Tuscumbia, the head of low-water navigation.

List of obstructions removed between July 26 and November 7.

Rocks removed from channel	53
Trees felled	29
Snags, etc., pulled	29
Trees, etc., cut up and disposed of	58
Miles of river cleared of obstructions	60

The river having been put in good navigable condition, the plant was taken to Lisle Town ferry-landing, 5 miles above the mouth of the Orange River, and all tools, tents, skiffs, etc., were stored in the warehouse and at the dwelling-house of Mr. William L. Huber.

The flat-boats, two open and two covered, used as quarter-boats, were hauled out upon the left bank of Maries River, 200 yards or so above its mouth. They were placed upon sills and, with the crab, were put in the best order to resist the dangers of the winter and spring months. Mr. William L. Huber, as watchman, was placed in charge of all United States property left at Lisle Town.

On November 7 field work ceased, and all members of the party except the watchman were discharged.

Shoals at present troublesome to steam-boat navigation, and of which particular complaint is made, are below Tuscumbia, and are as follows:

Berry's, where there are old works; Kirkman's, where there are old works; Clark's Island, where there are no old works; Rice's, where there are old works.

At Bolton Shoal, about 19 miles above the mouth of the river, the training-wall near its lower end has been undermined and washed away for a distance of about 100 linear feet. There is no complaint or cause of complaint at this shoal; still the wall should be repaired when convenient.

Twenty thousand dollars expended at the above points would undoubtedly temporarily improve navigation.

I have the honor to be, very respectfully, your obedient servant,

J. W. BEAMAN,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

UP THE RIVER.

Articles	Quantity.	Value.
Year ending June 30, 1888:		
Estimated value of steam-boat commerce		$75,653.50
Year ending June 30, 1889:		
Estimated commerce of steamers *General Meade, Benton, and Black Diamond*		40,000.00
Flour, sacks	132	330.00
Salt, barrels	1,130	1,695.00
Nails, kegs	627	1,881.00
White-pine lumber, feet	382,000	11,460.00
Coal, bushels	1,800	720.00
Farm machinery, tons	37	3,700.00
General merchandise, do	1,015	50,750.00
Total		110,536.00

Total value of commerce of river, 1888 ..... $583,414.33
Total value of commerce of river, 1889 ..... 692,834.90

DOWN THE RIVER.

Articles.	Quantity.	Value.
Year ending June 30, 1888:		
Railway ties	1,000,000	$333,333.33
Oak, ash, elm, and sycamore logs, feet	1,040,000	8,320.00
Walnut logs, do	100,000	2,000.00
Estimated value of steam-boat commerce		164,107.50
Total		507,760.83
Year ending June 30, 1889:		
Railway ties	1,000,000	250,000.00
Oak, ash, elm, and sycamore logs, feet	1,538,000	12,304.00
Walnut logs, do	36,000	720.00
Walnut lumber, do	65,000	2,275.00
Estimated commerce of steamers *General Meade, Benton and Black Diamond*		65,000.00
Wheat, bushels	182,153	145,722.40
Corn, do	4,250	1,487.50
Clover seed, do	200	800.00
Hay, bales	1,629	3,240.00
Eggs, cases	550	1,650.00
Hogs, head	2,550	30,600.00
Cattle, do	520	7,800.00
Sheep, do	450	900.00
Flour, sacks	1,500	3,750.00
Wood, cords	500	1,250.00
Barytes, tons	500	2,500.00
General merchandise, do	846	12,300.00
Total		572,298.90

List of steam-power boats engaged in commerce on Osage River during the year ending June 30, 1889.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Benton	197	28	5	394.08
Black Diamond	72.5	14.4	2.3	18.40
Dan. B. Hurlbut	62.6	11	2.4	12.92
Frederick	98.4	14.3	3	82.51
General Meade	192	30	4.3	171.46
John R. Hugo	127	20	3	136.88
Albert S. Willis	153.1	26.5	3.6	182.99

Y 5.

PRELIMINARY EXAMINATION OF GRAND RIVER, MISSOURI.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., December 17, 1888.

SIR: In accordance with instructions contained in letter dated Office of the Chief of Engineers, United States Army, Washington, D. C., August 28, 1888, I have the honor to make the following report on a preliminary examination of the Grand River, Missouri.

Grand River, Missouri, is a tributary of the Missouri River, emptying into the latter at a point near the town of Brunswick. It is formed by the junction of its two forks near Utica, Mo., and from this point to its mouth is about 80 miles by the stream. It drains a large area, about one-fourth of that portion of the State of Missouri situated north of the Missouri River.

Grand River was declared navigable as far as Bedford by the Missouri legislature on the report of a committee appointed for that purpose in 1838. During the years 1848 to 1859 several steam-boats made regular trips to Bedford, 60 miles above the mouth, occasionally running to Utica, 20 miles above Bedford.

Three railroad bridges have been placed across the river below Bedford, closing the navigation to all but very small steam-boats. These bridges are from 10 to 15 feet above the usual high-water stage, with an average channel width of 125 feet between the piers. After the construction of the bridge at Brunswick, in 1867, up to 1869, a small steam-ferry made regular trips in the lower portion of the river, passing under the bridge without difficulty.

Information as to the value or amount of steam-boat freight carried above Brunswick could not be obtained. Of late years log-rafting has been the only business on the river, the average yearly amount being 500,000 feet; but even this work is greatly obstructed by the piling under the bridge at Brunswick, which entirely closes the river during its low-water stages.

The plan proposed by those interested in the improvement of the river is to straighten as much as possible its numerous bends between Utica and Brunswick, thereby increasing the depth and current of the river, not for the benefit of navigation, but with the view of reclaiming a large amount of waste land through which it flows.

The only obstacle to the navigation of the river from its mouth to Brunswick, a distance of 3 miles, has been the bar which formed nearly across the river, just above its mouth, during the high stages of the Missouri River. Since 1875 this bar has remained in the same position,

leaving, during low-water stages of the river, a depth less than 2 feet for the outlet of the Grand River.

This bar, however, began moving with the break-up of the ice in 1888. A strong current in the Grand River from a continued spell of high water has washed most of the bar into the Missouri. Soundings taken October 11, with the river 1 foot above the standard low-water stage, show a depth of 7 feet opposite Brunswick, 10 feet and over to the mouth, and a depth of 5 feet over the bar, with a channel width sufficient for the passage of Missouri River steam-boats. The removal of six or seven snags would clear the channel to Brunswick.

An improvement work at the mouth of the river to maintain the present channel is not immediately necessary, as the conditions by which the bar was first formed have changed. In 1875 the channel of the Missouri River passed directly by and at right angles to the mouth of the Grand, causing a large eddy in the latter river, which deposited the bar. The channel of the Missouri at this point is now in the middle of the river, affording the Grand during its high stages better chances of washing out any bars that may be deposited during high water on the Missouri River.

In the days of steam-boating Brunswick was one of the largest shipping points on the Missouri, but the changes in the channel of that river from the year 1860 to 1868 placed Brunswick on the Grand River, 3 miles from the Missouri. From 1867 the opening of the Wabash Western Railroad, which passes through Brunswick (to 1875), the year in which Grand River was closed by the bar at its mouth the average amount of tobacco shipped yearly by river was 3,500,000 pounds. Information as to other shipments could not be obtained, as the records have been lost.

The amount of yearly shipments in future by the river, provided boats are running and maintain freight rates lower than the railroads, was estimated by the merchants of Brunswick as follows:

	Pounds.
Grain and flour, export	6,000,000
Tobacco, export	3,000,000
Stock, export	3,000,000
Brick, export	3,000,000
Lumber and logs, import and export	3,000,000
Merchandise, import	2,500,000
Coal, import	2,000,000
Total	22,500,000

The river may be divided into two portions; first, that below Brunswick; and second, that portion between Utica and Brunswick.

The river from the mouth to Brunswick at present needs no work of improvement to render it navigable when the Missouri is navigable, except the removal of snags, which can be done by the snag-boat working in the Missouri River without any material extra expense.

As to the improvement of that portion of the river between Utica and Brunswick, it is not worthy of improvement for navigable purposes, there being no demand for commerce on this portion of the river.

The following joint resolution was passed by the Missouri Legislature in 1887:

JOINT AND CONCURRENT RESOLUTION instructing our Senators and requesting our Representatives in Congress to use all means proper in their legislative capacity to secure an appropriation of $50,000 for the purpose of straightening Grand River.

Whereas there are at least 500,000 acres of swamp lands, known as bottom lands, lying along Grand River, in north Missouri, which, by reason of frequent overflows, caused by the tortuous meanderings of said river, are rendered comparatively worthless and uninhabit; able and

Whereas it is believed from careful estimates that, by the judicious expenditure of $50,000, the channel of said river can be so straightened, and reduced in length one-half at least, if not more, and its fall be increased from 7 inches to at least 15 inches to the mile, and the capacity of the river to drain its water-shed be increased at least fourfold, and thereby practically reclaim this large body of rich alluvial land, which is unsurpassed in fertility by the lands of any portion of the great Mississippi Valley, and render it capable of furnishing homes for thousands of families, thus adding to the material wealth and resources of the State and of the nation: Therefore be it

Resolved by the Senate, the House of Representatives concurring therein,

First. That our Senators in Congress be instructed, and our Representatives in the fiftieth session of Congress be requested, to use all means proper in their legislative capacity to secure the appropriation of $50,000 for the purpose of straightening and improving Grand River and reclaiming the swamp and bottom lands lying along said river.

Second. That the secretary of state be required to transmit to each of our Senators and Representatives in the Fiftieth Congress a copy of these resolutions.

Approved March 31, 1887.

At the request of the Hon. C. H. Mansur, member of the House of Representatives from the Second district of Missouri, I made a personal examination and investigation in reference to the method of straightening the upper portion of the river. The soil through which the river meanders is a soft alluvium, and the very fact that the course of the stream is now so tortuous is due to its want of tenacity. If the stream were straightened it could not be kept so without great expense, and would eventually lengthen itself to a slope—probably the present slope—and resume its curves and bends. Although it would be of great local benefit to prevent the Grand River from overflowing its banks and thus reclaim the rich alluvial lands along its bottom, the general needs of commerce do not demand any work on this river.

I would therefore, in view of the above facts, state that in my opinion the river is unworthy of improvement and a survey is not necessary.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Y 6.

PRELIMINARY EXAMINATION OF ST. LOUIS HARBOR, MISSOURI.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., December 22, 1888.

SIR: In compliance with instructions contained in letter dated Office of the Chief of Engineers, U. S. Army, Washington, D. C., August 28, 1888, I have the honor to make the following report on a preliminary examination of the St. Louis Harbor:

The information in the possession of this office is sufficient without the necessity of a preliminary examination or survey.

St. Louis Harbor may be divided into two parts, the upper and the lower harbor, the line of division being the Eads Bridge.

The lower portion, included between the river des Peres and the bridge, is 8 miles long. In this portion the channel is good at all stages of water and the landings easily accessible at all points.

The upper portion, included between the bridge and the northern limits of the city of St. Louis, is about 10 miles in length; of this portion the

only part to be considered, as at present included in the practical harbor, is the reach between the bridge and the Water Works at Bissell's Point, and is 3 miles in extent.

The reach below the bridge may be considered as completed, and requiring no improvement either for the purpose of facilitating navigation or to improve landing facilities.

The reach above the bridge and below Bissell's Point becomes, at low water, obstructed by bars and shoals near the Illinois shore, which interfere with landings on that side. These landings are only used by ferry-boats, and they are obliged on such occasions to change their landing places to suit the stage of water.

In order to secure good landings in this portion of the harbor at low stages it is necessary to contract the width of the river from a point opposite Bissell's Point to a point 4,500 feet above the bridge, or for a distance of 13,000 feet, to a width of 2,000 feet.

The commerce of this portion of the river consists of what arrives from the Missouri and Upper Mississippi rivers and what crosses the ferries to and from the railroad freight-yards on the Illinois side, and for the year 1887 was as follows:

River.	Articles.	Receipts.		Shipments.	
		Tons.	Estimated value.	Tons.	Estimated value.
Mississippi River above St. Louis.	Merchandise and grain.	132,400	$3,605,257.03	36,170	$1,035,100
Do	Lumber, shingles, etc.	.....	2,431,215.93	.....	.....
Missouri	Merchandise and grain.	27,700	982,400.05	14,580	427,400
Illinois	....do	78,560	895,652.88	7,125	213,750
Total	.....	238,660	7,914,585.87	57,875	1,736,250

Wiggins Ferry Company, between Venice, Ill., and St. Louis, shipments and receipts 511,403 tons.

The obstructions to navigation in the upper harbor, as before mentioned, consist of the bars formed at low water by a too great dispersion of the water at this stage. By contracting the width of the river at low water it is probable that these obstructions will be removed. The width to which the river has been contracted in the work of improvement, when complete, below St. Louis, has been 2,500 feet, and wherever this has been accomplished it has resulted in the removal of bars and the obtaining of a good navigable channel at all stages. The width of 2,000 feet for the reach above the bridge would seem better, in order to prevent a too great gorging of the water at the bridge, which at low water gives a clear water-way of not more than 1,500 feet. If it is found that a contraction to 2,000 feet is not sufficient, the additional contraction to 1,500 feet could be added afterwards.

I would propose to do this contraction work by the same method now employed on the Mississippi River below St. Louis, and which has succeeded at the locality known as "Horsetail," that is, by building out from the shore permeable pile and brush hurdles to the proposed line of contraction, placing the hurdles a distance of 1,000 feet apart; this for a total distance of 13,000 feet would require fourteen hurdles whose total length would be 19,800 feet at a cost, estimated from actual work done in this locality, of $8.35 per linear foot, which would amount to $165,330; adding 10 per cent. for engineering, contingencies, etc., the total cost will be $181,863.

The city of St. Louis has at present a population of 500,000 and is steadily advancing in manufactures and commerce; it is therefore not probable that the demands of commerce for this improvement will ever be less in future than at present. I am therefore of the opinion that the harbor of St. Louis is worthy of improvement, and would recommend that an appropriation of $182,000 be made for that purpose. I would also recommend that if an appropriation be made, it be made in one entire sum, enough for the completion of the work, as otherwise the work would cost much more than the above estimate.

A tracing of a recent survey of the upper harbor, with proposed works outlined thereon, is forwarded herewith.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Y 7.

PRELIMINARY EXAMINATION OF MISSOURI RIVER AT MIAMI, MISSOURI.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., December 19, 1888.

SIR: In accordance with instructions contained in letter dated Office of the Chief of Engineers, U. S. Army, Washington, D. C., August 28, 1888, I have the honor to make the following report on a preliminary examination of the Missouri River at Miami.

The town of Miami, with a population of 800, is situated on a bluff on the right bank of the Missouri River, 267 miles above its mouth.

The only outlet at present for its commerce is by the river to De Witt, a station on the Wabash Western Railroad, 4½ miles below Miami, on the left bank of the river. The mail route is *via* Miami Junction, a station on the same railroad 2 miles across the bottom-land from Miami.

All of the freight between Miami and De Witt since January, 1877, has been carried by the steam ferry *Mattie Lee*, of 100 tons burden, drawing 3 feet when loaded.

The amount handled is given in the following table:

From Miami to De Witt.

	Weight.	Value.
1887.	*Pounds.*	
Grain	7,974,000	$86,385
Apples	24,000	225
Stock	944,000	41,300
Miscellaneous packages	46,820	(*)
1888 to September 30.		
Grain	6,300,000	73,500
Stock	625,000	27,300
Miscellaneous packages.	30,000	(*)
Total	15,943,820	$228,710

* The value of these shipments could not be ascertained.

General merchandise from De Witt to Miami.

	Weight.	Value.
	Pounds.	
1887	1,235,900	.....
1888 to September 30	1,309,700	.....
Total	2,545,600	$271,500

The purpose of an "appropriation for Miami," as given in the petition signed by one hundred and seventy of the citizens and adjacent land-owners, and presented towards the close of 1887 to the Hon. J. T. Heard, M. C., was for Government aid in protecting their caving land.

The shore-line, as given by the surveys of the Missouri River in 1878, in 1882, and by the present examination, shows a caving bank for a distance of 16,000 feet below Miami, representing a loss of 192 acres since the survey of 1878. The caving was greatest in the years 1881 and 1883, during the extreme high-water periods. At the upper end of the caving bank the shore-line has receded a distance of 1,000 feet, but this part of the bend has deepened to such an extent that a bar has now formed along the shore, throwing the low-water channel to the bar on the other side of the river, returning into the lower portion of the bend, where the bank for a distance of 3,000 feet has receded an average of 800 feet since the survey of 1882.

The bank opposite Miami has also caved very rapidly since 1881, the shore-line receding 1,200 feet, a loss of 161 acres in a length of 9,000 feet in which the caving occurred. The largest loss at this point was during the high water of 1881. Since then the loss each year has been about the same.

	Acres.
Loss below Miami	192
Loss opposite Miami	161
Total	353

This land was worth from $15 per acre for the unimproved to $40 per acre for the improved, or an average of $30 per acre, as most of it was improved, which represents a loss of $10,590.

Previous to 1881 the width of the river at Miami was 1,200 feet, but the continued caving of the bank opposite has increased its width to 2,400 feet, resulting in the formation of a large middle bar. For a number of years the channel has been on the right bank, the Miami side of the river, but the crossing from the left bank has been gradually working lower down, until the present low-water channel crosses just above this middle bar into the lower landing at Miami.

An improvement work at this locality is needed to hold the channel to the Miami side of the river, for the changes liable to occur after a few stages of high water will probably shift the channel to such an extent as to leave Miami without a low-water steam-boat landing.

The river and harbor act of August 11, 1888, provides as follows:

Improving Missouri River from mouth to Fort Benton: Continuing improvement, one million dollars, to be expended under the direction of the Secretary of War, in accordance with the plans, specifications, and recommendations of the Missouri River Commission, except as hereinafter modified.

Out of the above sum the following amounts shall be applied to the purposes hereinafter specified, namely, * * * that the sum of twenty-five thousand dollars, or so much thereof as may be necessary, shall be expended on said river at or near Miami, Missouri.

From this it appears that an appropriation for the improvement of the Missouri River at Miami has already been made, and its expenditure is placed by law under the supervision of the Missouri River Commission, and that a report as to whether the locality is worthy of improvement is superfluous, as the question has been already decided by Congress.

I view of the above, I would respectfully recommend that the matter be referred to the Missouri River Commission.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX Z.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE DES MOINES RAPIDS AND THE MOUTH OF THE ILLINOIS RIVER.

REPORT OF CAPTAIN E. H. RUFFNER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENT.

1. Mississippi River, between the Des Moines Rapids and the mouth of the Illinois River.

EXAMINATION.

2. Clarksville Harbor, Missouri.

Z 1.

IMPROVEMENT OF MISSISSIPPI RIVER, BETWEEN THE DES MOINES RAPIDS AND THE MOUTH OF THE ILLINOIS RIVER.

UNITED STATES ENGINEER OFFICE,
Quincy, Ill., July 9, 1889.

SIR: I have the honor to render the following as my annual report in the "Improvement of the Mississippi River between the Des Moines Rapids and the mouth of the Illinois River," for the year ending June 30, 1889.

At the beginning of the year the balance on hand was only $327.05, and nothing was done therefore until after the organization under the provisions of the act of 1888. Upon the day after notification was received by me that the river and harbor bill was a law, I made a general report, outlining a method of "repairing the washouts in the Suy Island levee, and strengthening the levee where it crossed Snicarte Slough and other sloughs," for which purpose $50,000 had been allotted in the bill. Advertisements were issued September 3 for bids for this work, and the bids were opened October 3, 1888. The abstract of bids follows. The contract was awarded to Price & King, of Topeka, Kans., for the whole work, at 10.9 cents per cubic yard.

Abstract of bids opened by Capt. E. H. Ruffner, Corps of Engineers, on October 3, 1888, in response to his advertisement of September 3, 1888, for "improving and strengthening Sny Island Levee where it crosses Sincarte Slough and other sloughs, and in repairing washouts in said levee."

Number.	Name and address of bidders.	Re-enforcing Sny Dam.	New levee above Hannibal.	Ecuse Crevasse.	Re-enforcing Big Cut-off Dam.	Murphy's Bay or Crooked Slough.	Godman Crevasse.	Re-enforcing Iowa Cut-off.	Breaks below Clarksville.
1	W. H. Raftery, Pittsfield, Ill.	.....	.....	.....	.....	.....	$0.14½	.....	.....
2	James B. Blake, James Higgins, Pittsfield, Ill.	.....	$0.14½	$0.14½	.....	$0.20	.....	.....	.....
3	*Reese H. Price, Patrick H. King, Topeka, Kans.	.....	.10⅝	.12	$0.12	.11½	.....	.....	.....
4	W. Overton Winston, Minneapolis, Minn.	.....	.12½	.17	.....	.17	.17	.....	.....
5	James J. Steers, St. Paul, Minn.	.....	16c. ea 18 ex.	.....	.....	.15	.....	$0.20	$0.25
6	Zachariah Fielder, Hannibal, Mo.	.....	.....	.....	.....	.....	.15	.20	.25
7	†A. J. Whitney, Rock Island, Ill.	$0.16	.14	.18	.25	.17	.18	.....	.....
8	John W. Bramwell, New Canton, Ill.	.....	.....	.....	.....	.19½	.19½	.....	.....
9	Theo. F. Beldin, Pearl Station, Ill.	.....	.....	.....	.....	.22	.22	.....	.....
10	J. Richtman, Fountain City, Wis.	.45	.....	.....	.....	.....	.....	.....	.....
11	Harlam F. P. Dodge, Atlas, Pike County, Ill.	.....	.16	.....	.....	.16	.16	.....	.17
12	†Wood & Penny, Warsaw, Ill.	.19	.17½ 15 ex.	.....	.....	.....	.19 .15 ex.	.....	.16 .15 ex.
13	Edward M. Rothwell, Stapmann, Mo.	.....	.14 7/16	.....	.....	.15 1/16	.15 1/16	.....	.....
14	S. M. Spencer, Payson, Ill.	.....	.....	.15	.....	.....	.....	.....	.....
15	Fruni Bambrick Construction Company, St. Louis, Mo.	.....	.14½	.....	.....	.14½	.....	.....	.....
16	§Fruni Bambrick Construction Company, St. Louis, Mo.	.....	.....	.....	.....	.....	.....	.....	.....
17	W. P. Cochran, New Canton, Ill. / W. Wilson, Halls, Ill.	.....	.....	.....	.....	.17½ / .18 ex	.17½ .18 ex.	.....	.....
18	James W. Summers, Keokuk, Iowa.	.22½	.18½	.18	.25	.20	.23	.25	.25
19	Ford F. Wilkinson, Keokuk, Iowa.	.....	.....	.....	.....	.18	.....	.....	.....
20	Bodkin & McCaughey, Quincy, Ill.	.....	.11½	.....	.....	.....	.....	.....	.....

*Will construct whole thing at 10.9 cents.
†At all points below Louisiana, 25 cents.
‡Irregular guaranties.
§For all other work, 17 cents.

The contractors began work promptly in October with a small force, and about as soon as the surveys were ready. They worked all winter, which proved to be exceptionally open and favorable for them. But they were not able to complete the contract in time—April 1—and an extension to June 1 was granted them. Fortunately for the interest of all concerned there was no high water in the river in the spring, and the repairs of the washouts was not interfered with as would have been the case in nine years out of ten past. The following is the list of localities where work was done, the amount, and cost:

Locality.	Cubic yards.	Cost.
Hannibal Bridge, overhaul	97,584.78	$10,636.74 256.54
Rouse's Crevasse	706.60	72.02
Murphy's Bay	46,700.40	5,162.48
Godman's Crevasse overhaul	6,463.20	704.49 6.64
Say Dam, overhaul	20,273.66	2,209.83 903.19
Big Cut-off Dam, overhaul	38,647.89	4,212.59 1,936.64
Canal Slough, overhaul	5,411.17	589.82 83.65
Iowa Cut-off, overhaul	5,283.67	575.92 34.14
Below Clarksville, overhaul	25,068.70	2,734.67 15.55
Total		30,134.91

For the repair and construction of rock and brush dams and shore protections during the season of 1889 bids were invited by advertisement dated October 29, 1888, and opened November 29, 1888. The following is the abstract of bids:

Name and address of bidder.	Between Keokuk and La Grange.			Between La Grange and Hannibal, Mo.			Operating "Coal Bluff" and barges below Hannibal.		
	Rock.	Brush.	Total.	Rock.	Brush.	Total.	Rock.	Brush.	Total.
	cu. yd.	cu. yd.		cu. yd.	cu. yd.		cu. yd.	cu. yd.	
Christ Masenger, Fountain City, Wis.	.....	.....	.....	$1.73	$0.97	$2.70	.....	.....	.....
L. B. Dellicker, Parkersburgh, W. Va.	.....	.....	.....	1.73	.49	2.22	.....	.....	.....
N. W. Tucker, Parkersburgh, W. Va.	.....	.....	.....	.....	.....	.....	$1.63	$0.44	$2.07
Isaac P. Luck, St. Louis, Mo.	$1.48	$0.70	$2.18	1.48	.70	2.18	.....	.....	.....
Sid. J. Truax, Hastings, Minn.	.....	.....	.....	1.40	.70	2.10	1.35	.70	2.05
A. J. Whitney, Rock Island, Ill.	1.29	.50	*1.79	1.29	.50	†1.79	1.00	.60	†1.60
Alonzo G. Amee, Quincy, Ill. Zachariah Fielder, Hannibal, Mo. Michael F. Langdon, Quincy, Ill.	.....	.....	.....	.....	.....	.....	1.10	.69	1.79
Albert Kirchner, Fountain City, Wis.	1.40	.70	2.10	1.37	.40	2.07	1.37	.75	2.12
Jacob Richtman, Fountain City, Wis.	1.44	.72	2.16	1.35	.72	2.07	1.15	.72	1.87
James Collins, Canton, Mo. Perry Mundy, Canton, Mo.	1.87½	.87½	2.75	.....	.....	.....	.....	.....	.....
Henry S. Hopkins, St. Louis, Mo. William F. Hopkins, St. Louis, Mo.	.....	.....	.....	.....	.....	.....	1.20	.65	1.85
H. S. Brown, Quincy, Ill	‡1.35	.70	2.05	1.30	.62½	1.92½	.....	.....	.....
Patterson Bros., Keokuk, Iowa.	1.70	.08	2.78	1.70	.40	2.10	.....	.....	.....

*Guarantee incomplete. †Accepted. ‡Certificate to guaranty incomplete.

The bid of A. J. Whiney, of Rock Island, being accepted for the whole work, contract was entered into with him December 12, and he began work promptly with the opening of navigation in March, and has done

good work since then. The following table shows the names and localities and amounts of work done up to June 30:

	Length.	Rock.	Brush.
	Feet.	*Cub. yds.*	*Cub. yds.*
Alexandria, Mo., repair of wing-dam and new shore protection	1,667	2,953	261
Fox Island Slough Dam	257	1,635	680
Fox Island shore protection	2,470	5,101	2,567
Raising Canton Chute Dam	1,135	4,495	3,005
Raising Smoot Chute Dam	375	138	146
Beebee Island Dam	1,760	6,995	738
Whitney's Bar wing-dam 1	750	3,676	2,030
Whitney's Bar wing-dam 2	1,000	4,033	2,842
Closing dam Islands 500, 501	202	1,613	806
Protection Island 521	1,000	1,615	1,001
Closing dam Islands 519, 520	450	3,200	1,973
Closing dam Islands 519, 516	550	1,510	1,058
Illinois shore protection opposite	2,650	2,095	2,082
Protection Island 519	572	484	484

In the execution of his contract, Mr. Whitney has placed 37,962.68 cubic yards rock, costing $45,921.76, and 23,670.22 cubic yards brush, costing $12,575.56; total, $58,497.32. His contract amounts to $95,000, and there are therefore liabilities to him of $36,502.68.

A break occurred in the Whitney's Bar Dam of 1887, in September, 1888. This was repaired by H. S. Brown, under public notice of ten days, and bids received, and there were used—

Rock, 489.71 cubic yards, at $1.50	$734.56
Brush, 250.10 cubic yards, at $1	250.10
Total	984.66

HYDRAULIC DREDGE.

The *Success* was borrowed in August by the St. Louis and Saint Paul Packet Company, and pumped the sand from under the steamer *War Eagle* that had been aground for a long time. In thirty-six hours enough sand had been pumped to allow the steamer to settle down of her own weight, so that she was easily got off. After the appropriation became available and an inspection had been made, it was thought best to set the *Success* at work at Whitney's Bar Crossing. This was her first experience in the river in pumping sand. The difficulty in working proved to be exclusively in the handling of the steamer and flats. Anchors and lines, and finally piles, proved insufficient to hold the boats still against wind and current, and good work was done only when in a favorable situation and on a quiet day. But the pump and machinery proved all that could be expected, and sand could be easily and continuously pumped through 400 feet of pipe without trouble. The depth on the "crossing" was finally improved, but work stopped in order to build "spuds" to a heavy flat, so that this could be put in place, spudded down, and the rest of the fleet attached to it.

The *Success* and fleet were loaned in December to Captain Leach for use at Plum Point. They returned in April, bringing 565 cypress piles. These were driven partly as mooring piles in Hamburg Bay, and partly as portions of pile-dams across island chutes between islands 476–477, 481–484, 484–485, 485–486, and to close a small chute near the mouth of Hamburg Bay. Some piles will be used to mark the harbor lines in Quincy Bay and the rest in the completion of the dams already begun, where the stage of water will permit. Besides doing this work the *Success* was laid up for repairs about ten days, and also was engaged in towing the dredge No. 2 on two occasions.

UNITED STATES DREDGER NUMBER 2.

The dredge was placed in order and sent down on April 15 to dig gravel and repair a large hole in Westport Chute Dam. She was engaged at this work until May 14, and dumped about 12,700 cubic yards upon the dam. The stage of the water was too low to do satisfactory work, and probably half or more of the material was washed away by the stiff current. From May 14 to 29 the dredge dug 3,706 cubic yards out of an obstructed channel leading from Mozier's towards Hamburg Bay. A cut 750 feet long and part of a second were made. Until June 18 the dredge was again at work on the Westport Chute Dam, and put something like 6,500 cubic yards gravel on it. Seeing that the work was not done to advantage, I had the dredge put in thorough repair and then set her at work digging gravel to be dumped just above one of the pile-dams put in to close the chute near Mozier's.

The launch *Iris* attends the dredge, and the *Success* moves it when necessary.

A survey has been made of Quincy Bay to be used in the determination of harbor lines, a subject now before a Board of Engineer Officers appointed to consider it.

The experiences of the past year do not warrant the introduction of any new recommendations by me. But it is proper to state that the United States steamer *Coal Bluff* can not safely be run another year without extensive repairs, which had better, in fact, be the removal of the hull and cabin. This boat has been a valuable one and has done good service. Not less than $12,000 should be spent in her renewal. The redecking of 6 model barges will be imperative next year, at perhaps $1,000 each, including calking and repairs to hulls. There are also 5 flats that will need about $500 each. In fact, the repairs due will amount to at least $21,000 to bring the fleet up to a state of efficiency. This fleet earned $28,000 in 1887, and about $6,500 this year—that is to say, contract work in those years cost that much more, by comparison of yards of material in place. To carry out existing project there could be profitably expended in this district $500,000 during the ensuing year. The channel during the past year has been about as usual, and there is every reason to expect extreme low water this summer and fall.

Money statement.

July 1, 1888, amount available		$327.05
Amount appropriated by act of August 11, 1888		200,000.00
		200,327.05
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$90,213.05	
July 1, 1889, outstanding liabilities	13,922.17	
July 1, 1889, amount covered by existing contracts	36,502.68	
		140,637.90
July 1, 1889, balance available		59,689.15
Amount (estimated) required for completion of existing project		Unknown.
Amount that can be profitably expended in fiscal year ending June 30, 1891		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Very respectfully, your obedient servant,

E. H. RUFFNER,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Z 2.

CLARKSVILLE HARBOR, MISSOURI.

UNITED STATES ENGINEER'S OFFICE,
Quincy, Ill., January 11, 1889.

SIR: I have the honor to forward herewith a report of a preliminary examination of Clarksville Harbor, Missouri, as required by letter of the Chief of Engineers dated September 3, 1888, together with a tracing showing a portion of the Mississippi River near the town.

Very respectfully, your obedient servant,

E. H. RUFFNER,
Captain of Engineers.

To the CHIEF OF ENGINEERS, U. S. A.

PRELIMINARY EXAMINATION OF CLARKSVILLE HARBOR, MISSOURI.

Clarksville is a place of between 1,500 and 2,000 inhabitants, situated about 100 miles above St. Louis, on the west bank of the Mississippi River, at the point where the river leaves the bluffs that it has been skirting for about 38 miles, and crosses over to the Illinois bluffs some 12 miles lower down. The bluffs on the Missouri shore are not encountered again upon the Mississippi below Clarksville until the vicinity of St. Louis is reached. This area of bottom land, belonging partly to the Mississippi and partly to the Missouri River, does not offer an advantageous site for a large city, and the situation of Clarksville is the only suitable position upon the river bank in Missouri for this long distance that can be utilized to any degree desired without great expense in future development, should such occur. Although the town is not large, yet it has some flourishing manufactories. In tobacco a large business is done, enough to justify a feeling of pride in the citizens of the place at the success already achieved. A vinegar factory and cider-mill consumes large quantities of apples that are raised in the vicinity, and there is also a paper-mill and a large and successful flour-mill, besides minor industries. On the Illinois side of the river, opposite Clarksville, lies a large and fertile bottom which has been placed under the protection of what is known as the "Sny Island Levee." Behind this levee are many farms which are brought into close relation with Clarksville through the ferry at that point. There is no town on the Illinois side of any importance near this region and no railroad nearer than that passing east from Louisiana, some 10 miles north of Clarksville. All of these facts conspire to render this town of some importance to both sides of the river. The additional fact that during the season of navigation there is constant communication with St. Louis by river through the principal packet lines, and also by a local line operating between St. Louis and Clarksville by frequent trips, enhances the value of Clarksville as a commercial center.

It is considered that the intercouse with the Illinois side is of so much importance to the town, that especial attention is given to the ferry communications. The ferry itself is a good boat, and well handled, and well adapted to the trade. The crossing of the river is about the same as it always has been and always is at river towns, that is, the length is about the same, and at times the route to be followed, or the landing on one or the other side is more or less interfered with by sand-bars at

low stages of the river. At these times there are occasions when circuitous routes must be followed, and sometimes the stage of the water is just such that a low flat bar will keep the boat some distance out from the bank, and teams must pass through the water to reach the boat, or the ferriage is discontinued until the water gets higher or lower. Now it has so happened that similar conditions formerly existing at Hannibal, Mo., and Louisiana, Mo., have in years past been much bettered through the action of Congress, which by granting special sums to each of these localities, enabled a forestallment of the general plan of improvement to be made by the building of a long and substantial dike from the Illinois shore out into the river. These dikes, or wing-dams, form parts of the system of low-water contraction of the channel of the river, and force it to occupy a more fixed position, while above and below these dikes are formed, solidified, and rendered stationary many masses of sand which otherwise would by constant shifting interfere with navigation. They also assist the ferries most materially by forcing a scouring away of the sand-bars between the ends of the dikes and the opposite shore, giving deep water from the dike end to the Missouri shore, and when the water is at a suitable stage the Illinois landing is on the end of the dike, and teams driven over it, to and from the shore, and the ferry-boat. The trip of the ferry-boat is shortened each time by the double of the length of the dike, which is about 1,000 feet in each case. For the particulars of the construction of these, and all the circumstances leading to the choice and execution of this particular application of the individual appropriations at Hannibal and Louisiana, see Report of the Chief of Engineers for 1881, Part II, pages 1721 and 1723. One point alone is a disadvantage to ferry interests from the construction of these dikes. There always comes a stage of water either on a rising, or on a falling river, when there is too much water on top of these dikes to allow of the teams to drive over them with safety, and there is not enough water to allow the ferry-boat to pass over the dike itself. The deposits of sand above and below the bars will in time raise the vicinity to nearly the same level as the dike itself, and hence it will not be practicable to reach the shore above or below the dike except when the water is of depth enough to float the boat over the dike. To raise the dikes above their present height is only a temporary expedient, and the same conditions will be renewed in time, for the safe limit of height is soon reached. Trouble is felt at both Hannibal and Louisiana from these causes, and at both places it is desired by interested parties that the dikes should be raised and lengthened.

Now, the people of Clarksville simply ask for the *same relief to be given their ferry interests that was given* in 1880 and 1881 to the places mentioned. The harbor of Clarksville proper is in admirable condition and always has been. So also the main steam-boat channel is, for several miles above and below the town, as good as it is anywhere, and no complaint has been raised by the steam-boat interests or the people of Clarksville; but a personal consultation held with those concerned in getting the clause in the bill upon which I am now reporting enables me to represent their wishes in the matter.

The wishes of the community can be granted and at the same time the plan of general improvement of the navigation of the river carried out in the following manner: It is intended in time to close the chute between Clarksville Island and the Illinois shore by a suitably-constructed dam, and it is also intended in time to build a wing-dam above the head of the island from the Illinois shore, in such direction and to

such a length as will serve to confine the channel to the Missouri shore, and what is of more importance, increase the stability and add to the mass of the sand now behind Clarksville Island to keep any of it from getting down into the next reach already glutted with a superabundance of moving sand. The map sent herewith shows the approximate position of these two works outlined in red. The wing-dam can be located so as to be about where desired by the parties interested, or at any rate can be used by them when built. It will be about 1,000 feet long and can be economically and advantageously built at a good stage of the river by dredging the gravel in a bar just below the town of Clarksville and depositing it in the line desired. This work can be done if authorized, either by contract or by the use of the United States dipper dredge. If done by the latter, and the stage of water were and continued favorable, for about $4,000. If a foundation of gravel were put in and then brush and rock were put on it, it would cost about $6,000. If the whole were built of rock and brush it would cost about $10,000. The dam behind the island should be built at the same time and would cost about $15,000. Both works could be built to advantage in one season for the sum of $25,000, and a material assistance be given to the general plan of improvement of the river.

I believe that Clarksville harbor is worthy of improvement as outlined above.

Respectfully submitted.

E. H. RUFFNER,
Captain of Engineers.

APPENDIX AA.

IMPROVEMENT OF THE NAVIGATION OF THE MISSISSIPPI RIVER BETWEEN MINNEAPOLIS AND DES MOINES RAPIDS, INCLUDING IMPROVEMENTS AT SPECIAL LOCALITIES BETWEEN THOSE POINTS; OPERATING AND CARE OF DES MOINES RAPIDS CANAL.

REPORT OF MAJOR ALEXANDER MACKENZIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. Operating snag-boats and dredge-boats on the Upper Mississippi.
2. Mississippi River from Minneapolis to Des Moines Rapids.
3. Des Moines Rapids, Mississippi River.
4. Operating and care of Des Moines Rapids Canal.
5. Dry-dock at Des Moines Rapids Canal.
6. Harbors of refuge on Lake Pepin, at Stockholm, Wisconsin.

EXAMINATIONS.

7. Moline City Harbor, Illinois.
8. Mississippi River, the main slough at Hamilton, Illinois, to the end of securing a good and sufficient steamboat landing at that point.
9. Mississippi River at and near the head of Beaver Island, at Clinton, Iowa, to determine what is necessary to remove the sand-bars there formed and forming, so as to make navigable and protect the entrance to the Western Channel, and the channel itself that runs between Beaver Island and the Iowa shore.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 8, 1889.

GENERAL: I have the honor to transmit herewith the annual reports upon the works in my charge during the fiscal year ending June 30, 1889.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

A A 1.

OPERATING SNAG-BOATS AND DREDGE-BOATS ON THE UPPER MISSISSIPPI RIVER.

The work covered by this appropriation is the removal of snags, wrecks, and other obstructions; the cutting and pulling back of overhanging trees, the clearing of shores, the searching for and marking of new channels, assisting stranded boats and barges, surveys and examinations in connection with new improvements, and for facilitating navigation through bridges, inspection and repair of existing works, formation of temporary or permanent channels through obstructing bars, and in general in benefiting commerce by aiding existing navigation and assisting in the permanent improvement of the Upper Mississippi.

The plant used in connection with this work is the snag-boats and dredges. At times when the plant is not required in connection with this special work it is used under general or special appropriations for work of permanent construction.

At the beginning of the fiscal year there was available for work under this appropriation the sum of $1,911.34. By the river and harbor act of August 11, 1888, the sum of $25,000 was appropriated for continuing the work of snag-boats and dredge-boats.

The snag-boat *General Barnard* was engaged in the work of removing snags, etc., during portions of July, August, September, and October, 1888, and May and June, 1889. The snag-boat *J. G. Parke* and dredge *Phœnix* were employed removing wrecks and cutting temporary channels during portions of September, October, and November, 1888, and May and June, 1889.

The details of work accomplished during the last fiscal year, as well as much statistical information, are given in the appended report of Assistant Engineer C. W. Durham.

By the river and harbor act of August 11, 1888, provision was made for operating snag-boats on the Upper Mississippi River under an indefinite appropriation, the sum so expended not to exceed the amount appropriated in said act for such purposes. The clause of the act regulating the annual expenditure for snag-boats and dredge-boats on the Upper Mississipp iis as follows: "For operating snag-boats and dredge-boats on Upper Mississippi River, $25,000."

Abstract of appropriations.

By act approved March 2, 1867	$96,000
By allotment from appropriation of July 25, 1868	26,000
By allotment from appropriation of 1869	35,640
By act approved July 11, 1870	36,000
By act approved March 3, 1871	42,000
By act approved June 10, 1872	42,000
By act approved March 3, 1873	25,000
By act approved June 23, 1874	25,000
By act approved March 3, 1875	25,000
By act approved August 14, 1876	30,000
By act approved June 18, 1878	41,500
By act approved March 3, 1879	20,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	25,000
By act passed August 2, 1882	25,000
By act approved August 5, 1886	22,500
By act of August 11, 1888	25,000
Total	549,640

Money statement.

July 1, 1888, amount available	$1,911.34
Amount appropriated by act of August 11, 1888	25,000.00
	26,911.34
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	26,911.34

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1889.

MAJOR: I have the honor to present my annual report of operating snag-boats and dredge-boats on the Upper Mississippi River for the fiscal year ending June 30, 1889, together with some statistics of commerce and navigation.

OPERATIONS OF SNAG-BOAT GENERAL BARNARD.

Details of operations of the *Barnard* in 1888 prior to July 1 were given in my last annual report.

On that date and until July 23 the *Barnard* lay at Fountain City, serving as quarters for men employed on construction work in that vicinity. On July 23 she proceeded up river, removing obstructions on the way, and arrived at Wabasha in the evening; returning down river, arrived at Prairie du Chien on the 25th; thence up river to West Newton, arriving on July 30. On the trip above-mentioned work in removing snags, leaning trees, etc., was performed at or near Minneiska, Prairie Crossing, Picayune Island, Chimney Rock, and Wacouta. Remained at West Newton and Alma until August 24, as quarters for men employed on construction work at West Newton Bar. On that date left for St. Paul, arriving August 28; returning thence down river, reached St. Louis September 14. On this trip obstructions were removed at or near Stockholm, Red Wing, Trenton, Smith's, Point Douglas, Nininger, Pine Bend, Frenchman's, Newport, Boulanger Slough, Hastings, Beef Slough, Coon Slough, Victory, Yellow River, Wyalusing, Cassville Slough, Parson's Bar, Solden's, Edward's River, Benton Island, Otter Island, North River, Marion City, Hickory Chute, Clarksville Chute, Carroll's Island, McCoy's Island, Mosier's, Turner's, McCann's, and Mason's Chute. Left St. Louis for up river September 17, and reached St. Paul October 9. October 10 to 12 worked above St. Paul. On this trip obstructions were removed at Missouri River, Piasa, Mason Chute, Enterprise Chute, Dixon's Two Branch Island, Cap au Gris, Maple Island, Sterling Island, McCoy's Island, Eagle Nest Island, Hickory Chute, Sny Slough, Orton's Island, Canton, Fox Island, Keithsburgh, Nine Mile Island, Waupeton, Genoa, Coon Slough, La Crosse, Diamond Bluff, Newport, Pike Island, and Boat Club Island. On October 12 proceeded down river, reaching St. Louis October 26; returning, arrived at Keokuk October 29, 1888, and laid up for the winter in the canal. On this trip work was performed at or near Newport, Merrimac, Pine Bend, Smith's, Blacksmith's Slough, Clayton, Glen Haven, Hackley Chute, Gregory's, Curtis Island, Whitney's, Scott's, and Louisiana.

In 1889, the *Barnard*, having been repainted and thoroughly repaired, was put in commission May 1, and between that date and the 24th operated between the mouth of the Missouri River and Rock Island. From May 24 to June 8 she was employed between Rock Island and Fort Snelling. Laid up at Hampton June 9, and used as quarters for men employed in the improvement of the Rock Island Rapids until the close of the fiscal year.

In May and June, 1889, obstructions were removed at or near Keokuk, Fox Island, Gregory's, Curtis Chute, Marion City, Armstrong's, Hannibal, Saverton, Mundy's, Blackbird Island, Hickory Chute, Alton, Piasa, Portage, Jersey Landing, Enterprise Island, Thomas Chute, Slim Island, McCoy's Island, Clarksville Island, Tully Island, Sauerwein's Bend, Benton Island, Hershey Boom, Turtle Island, Lyons, Keller's, Arnold's, Sand Prairie, Bellevue, Galena River, Maquoketa Slough, Parson's Bar, Cassville Slough, Glen Haven, Clayton, Coon Slough, Brownsville, Picayune Chute, Newport, Merrimac, Pine Bend, Trenton, Dakota, Dresbach, and above St. Paul.

SUMMARY OF OPERATIONS OF SNAG-BOAT GENERAL BARNARD FOR FISCAL YEAR ENDING JUNE 30, 1889.

Snags removed	361
Leaning trees pulled back	58
Leaning trees felled and removed	1,976
Wrecks removed	1
Steam-boats assisted	1
Miles run	6,174

The *Barnard* was in snagging commission during the fiscal year 123 days.

OPERATIONS OF SNAG-BOAT J. G. PARKE.

The *Parke* was employed in 1888 as tender to dredge *Phœnix* in channel dredging at Winona and Chimney Rock. She was put in commission October 20 and laid up in Des Moines Rapids Canal November 16.

In 1889, having been repaired and outfitted, she was put in commission March 28. From that date until April 12 she was employed in towing steamer *Alert* from Nininger to Davenport and dredge *Phœnix* with two dumps from Heytman's Landing to Keokuk. From April 12 to May 8 she was employed as tender to dredge *Phœnix* in removing wrecks between Keokuk and Grafton, and from May 8 to the close of the fiscal year in transferring plant, towing coal-flats, and as tender to dredge *Phœnix* in channel improvement near Wabasha.

OPERATIONS OF UNITED STATES DREDGE NO. 3 (PHŒNIX).

Between St. Paul and Hastings: The *Phœnix* was repaired at Wabasha and started up river in tow of the *Fury* September 12, 1888. Arrived at Island No. 17 September 14 and operated at that locality, at first to make a temporary channel for boats while the works for improvement were being constructed, and afterwards in deepening and widening the proposed permanent channel. She succeeded in making a cut through the bar 100 feet wide and 4 feet deep. On September 25 moved to Frenchman's Bar. Dredging operations at this locality were continued until October 12, by which time a cut had been made through the bar 1,500 feet long, from 40 to 75 feet wide, and 5 feet deep. On October 15 to 18 the rock patch below Gray Cloud Landing was removed by the dredge, the material consisting of a mixture of bowlders, sand, and clay. On October 19 to 22 the dredge was employed at the mouth of Boulanger Slough, deepening the passage to the quarries and winter harbor of the United States fleet. At different times the tow-boat *Fury* and steam launches *Louise* and *Stella* served as tenders to the dredge.

The cost of the work was $2,728.52; the number of cubic yards of mixed material removed, 27,000; the average cost per cubic yard of material moved, 10 cents. At Islands 53 and 55, Winona and Heytman's Landing: October 23 the dredge was taken in tow by the *Parke* and moved down river to Island 53. At this place a portion of the head of the island was dredged away in order to widen the channel. On October 27 a large snag at head of Island 55 was taken out. From October 29 to 31 the dredge operated in vicinity of Winona, deepening the channel and taking out about 2,500 cubic yards of material. On November 6 the dredge was employed in deepening the mouth of the harbor at Heytman's Landing and went into winter quarters there.

Removing wrecks below Keokuk: During a portion of the month of April, 1889, the *Phœnix* was employed in wrecking below Keokuk. She succeeded in destroying and removing the wrecks of the *Highland Mary*, *Archer*, and barge at head of Iowa Island. While working at the *Mollie McPike*, the dipper handle was broken and the wreck was abandoned, partially destroyed.

Cost of above work, including transfer of dredge from Heytman's Landing to Keokuk, was $2,853.13.

DREDGING AT EASTMOOR.

In September, 1888, the bar at Eastmoor, near Winona, became very troublesome. A dredging plant in this vicinity was hired and operated September 20 to 22, inclusive, removing about 2,200 cubic yards of material and deepening the channel considerably. Cost of this work, $346.59.

DREDGING AT CAMPBELL'S CHAIN, ROCK ISLAND RAPIDS.

In September, 1888, it was found that the head of the cut at Campbell's Chain was much obstructed by sand, as also the channel for some distance above. A dredging

plant was hired and operated on the bar from September 11 to 22. It succeeded in opening a good channel through the reef and no further trouble was experienced during the season. Cost of this work, $880.80.

REMOVING WRECKS OF PRAIRIE BIRD AND WYMAN X.

In October, 1888, the wreck of the *Prairie Bird*, about 1 mile above Keithsburgh, and that of the *Wyman X*, about 1 mile below Fort Madison, were easily removed by United States Dredge No. 1, at a cost of $356.

SUMMARY OF EXPENDITURES DURING FISCAL YEAR ENDING JUNE 30, 1889, "OPERATING SNAG-BOATS AND DREDGE-BOATS ON THE UPPER MISSISSIPPI RIVER."

Snag-boat *General Barnard*, repairs and outfit	$1,535.60
Snag-boat *General Barnard*, operating	14,742.08
Snag-boat *J. G. Parke*, repairs and outfit	443.46
Dredging temporary channels between St. Paul and Hastings	2,728.52
Dredging temporary channels at Winona and other points	1,383.11
Dredging temporary channels at Eastmoor (hired plant)	346.59
Dredging cut at Campbell's Chain (hired plant)	880.80
Removing wrecks of *Prairie Bird* and *Wyman X*	356.00
Removing wrecks below Keokuk	2,853.13
Care of plant	1,100.00
Superintendence and office expenses	542.05
Total	26,911.34

RIVER NOTES.

In 1888 the river continued at a high stage until the end of May. There was an excellent boating stage until the first week in September, at which time some of the bars began to give trouble. During the remainder of the season the river did not reach a very low stage, but the influence of the long-continued stage of high water was manifest in the deteriorated condition of the channel at many points. The river below Keokuk was in a very bad condition during latter part of September and in October.

In 1889 to July 1 the river continued very low for the season, but there was a fair boating stage until June, during which month much trouble was experienced by navigators in the upper part of the river. The running of logs in the river from the Chippewa River to Alma, initiated this year, has caused much inconvenience, danger, and delay.

I give a list of soundings in feet on some of the worst bars at the low-water period of 1888: Frenchman's, 3.0; Pine Bend, 4.0; head of Lake Pepin, 3.0; below Read's, 4.0; above Wabasha, 4.0; Teepeeota, 4.0; above Beef Slough, 4.0; Alma, 4.0; Eastmoor, 3.5; Grand Crossing, 4.0; below Bad Axe, 4.0; Crooked Slough, 4.0; Bellevue, 4.0; Arnold's, 4.0; Hershey Boom, 3.5; Appanoose, 3.5; Devil's Island, 3.5; Buzzard Island, 4.0; Tully Island, 3.5; Whitney's, 4.0; Cincinnati, 4.0; Hatchet Chute, 3.5; Perry Island, 4.0; Enterprise Island, 3.5; Two Branch, 4.0.

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business connected with the navigation of the upper Mississippi River and its principal tributaries is the lumber trade, which gave employment in 1888 to about 100 raft-boats, valued at $750,000. Between St. Paul and St. Louis 74 saw-mills were operated by 61 wholesale lumber firms having an invested capital of about $35,000,000. Their manufactures in 1888 were, lumber, 1,048,951,386 feet B. M.; shingles, 423,655,050. In addition to the manufacturers there are large numbers of retail or distributing firms scattered along the river. In 1888 toward the latter part of the season was inaugurated on an extensive scale the rafting of logs from the river above St. Paul. Twenty-seven rafts were taken out of the St. Paul River. Hitherto but a comparatively small amount of logs and lumber has been moved in the river above the mouth of the St. Croix River.

Steam-boats and freight.—The principal steam-boat lines on the upper Mississippi River are the St. Louis and St. Paul Packet Company, the Diamond Jo Line, and the Eagle Packet Company. There are also many independent boats carrying freight and passengers. During 1888 the amount of freight carried was 1,680,960 tons and the number of passengers carried, including those of ferry and excursion boats, was about 1,970,640.

Statement of amount of freight received and shipped from St. Louis by the Upper Mississippi for five years.

St. Louis.	1888.	1887.	1886.	1885.	1884.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Received	114,940	132,400	140,880	117,445	129,895
Shipped	50,315	36,170	46,190	48,295	43,110
Total	165,255	168,570	187,070	165,740	173,005

1888.

Steam-boats and barges from Upper Mississippi River arrived at St. Louis 872
Tons of lumber and logs received at St. Louis from Upper Mississippi River by raft 130,855
Steam-boats and barges departed from St. Louis for Upper Mississippi River 870

Receipts of lumber, logs, etc., at St. Louis from Upper Mississippi River, during 1886, 1887, *and* 1888.

	White-pine lumber.	Cotton-wood lumber.	Total lumber.	Shingles.	Lath.	Pickets.	Total pieces shingles, lath, and pickets.
	Feet.	*Feet.*	*Feet.*	*No.*	*No.*	*No.*	*No.*
1888	79,311,357	8,734,000	88,045,357	25,743,500	14,650,367	273,744	40,667,611
1887	136,490,666	6,436,000	142,926,666	70,370,735	43,034,705	448,060	113,853,500
1886	124,154,170	3,925,500	128,079,670	48,483,000	37,154,600	862,330	86,499,930

Receipts and shipments of flour, grain, and provisions by Upper Mississippi River boats in 1888, *port of St. Louis.*

	Receipts.	Shipments.	Total.
Flour, barrels	66,701	1,575	68,276
Wheat, bushels	326,675	.....	326,675
Corn, do	73,900	453	74,353
Oats, do	313,880	5,310	319,190
Rye, do	6,077	.....	6,077
Barley, do	429	.....	429
Pork, barrels	.....	515	515
Hams, pounds	20,435	236,970	257,405
Meats, do	84,410	165,880	250,290
Lard, do	11,340	914,030	925,370

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last three years:

Statement of steamers, barges, and rafts passing various bridges.

Locality of bridge.	Steam-boats.			Barges.			Rafts.		
	1888.	1887.	1886.	1888.	1887.	1886.	1888.	1887.	1886.
Hastings	521	805	820	424	971	909	26	26	25
Winona	4,740	4,300	4,570	684	1,600	974	1,894	1,100	1,880
La Crosse	5,242	4,213	4,347	279	578	587	1,683	1,451	1,485
Dubuque	5,649	6,088	4,766	791	1,107	1,221	930	841	728
Sabula	2,315	3,049	2,912	927	(*)	1,110	†577	(*)	†23
Clinton	2,627	2,753	2,998	405	650	623	†365	†564	†543
Rock Island	2,699	2,660	2,393	143	271	139	828	774	784
Burlington	1,598	1,658	1,558	274	312	312	302	291	(*)
Keokuk	1,886	1,618	1,380	1,844	808	808	245	344	229
Quincy	1,959	1,959	1,708	595	859	770	317	361	291
Hannibal	2,125	1,551	1,515	234	516	494	315	(*)	(*)
Louisiana	1,110	1,036	1,082	278	494	463	92	98	96

* No record. † Partial record.

Customs revenue and tonnage for the year ending December 31, 1888.

Port.	Collections.	Tonnage enrolled.	Vessels.
St. Louis, Mo.*	$1,458,857.50	130,519.17	214
Burlington, Iowa		4,974.93	77
Dubuque, Iowa	243.68	5,566.32	38
La Crosse, Wis		3,957.96	46
Galena, Ill	2.48	3,490.74	32
St. Paul, Minn	203,541.31	7,124.46	68
Total	1,662,649.92	155,633.60	455

* Only a part of the St. Louis statement applicable.

Internal revenue for the year ending December 31, 1888.

District.	Office.	Amount.
Minnesota	St. Paul	$518,920.18
Second Wisconsin	Madison	333,856.62
Third Iowa	Dubuque	154,104.26
Fourth Iowa	Burlington	275,817.67
Fifth Illinois	Peoria	17,885,760.60
Aggregate		19,218,539.33

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

A A 2.

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM MINNEAPOLIS TO DES MOINES RAPIDS.

Previous to August 11, 1888, this work was carried on under appropriations for "Improving Mississippi River from St. Paul to Des Moines Rapids." The act of August 11, 1888, extended the upper limits of the district from St. Paul to Washington Avenue Bridge, Minneapolis.

Under this head of appropriation are carried on works for permanent improvement of through navigation. These works, which have been fully described in previous reports, consist in construction of rock, brush, piles, and gravel, which close side chutes and reduce the low-water channel to a proper width, and in the protection of caving banks. The appropriation also provides for a certain amount of dredging and other temporary work for the more rapid and immediate removal of obstructions to navigation.

WORK OF PAST YEAR UNDER BALANCE OF APPROPRIATION "IMPROVING MISSISSIPPI RIVER FROM ST. PAUL TO DES MOINES RAPIDS."

General improvement.—The construction of dams and shore protections for the regulation of the low-water channel was carried on by days' labor and Government plant between St. Paul and Prescott, in the vicinity of Fountain City, at West Newton Bar, and between Otter

Island and Nauvoo. Buoys were, as usual, maintained on Rock Island Rapids. Extensive repairs and additions were made to plant. Surveys were made on Rock Island Rapids, between Fairport and Muscatine, between Read's Landing and Winona, at head of Lake Pepin, in vicinity of Keithsburgh, and between Fort Madison and Montrose. Examinations were made at the various localities where work was in progress. All the details of these works are given in full in the appended reports of U. S. Civil Engineer M. Meigs and Assistant Engineer C. W. Durham, the latter report containing full extracts from the report of Superintendent J. D. Dushane.

Harbor at Lake City, Minnesota.—A full description of this work is given in my last annual report under the heading of "Harbors of Refuge on Lake Pepin, at Lake City, Minnesota."

In August, 1888, a small amount of work was done for the repair of the slight damage caused by ice during the spring of 1888.

It is not thought that any extension of this work is immediately necessary and the balance on hand is sufficient for ordinary repairs.

Testing Adams flume.—The work of Mr. Adams, in connection with the test of his flume, was suspended by order of the Secretary of War in October, 1887. There still remain outstanding, in connection with the work, bills amounting to $32.75; the parties to whom these accounts are due can not be found. A full report on this work is given in my last annual report.

All the field work of the year under appropriation for "Improving Mississippi River from St. Paul to Des Moines Rapids" was completed during the calendar year 1888. Since January 1, 1889, the work and expenditures have been in connection with office expenses, survey work, and repairs and construction of plant.

"IMPROVING MISSISSIPPI RIVER FROM MINNEAPOLIS TO DES MOINES RAPIDS."

The river and harbor act of August 11, 1888, appropriated $600,000 for this work and also provided for a survey and examination of the Rock Island Rapids with a view to determining the proper method of further improvement.

A survey of Rock Island Rapids was made in September, October, November, and December, 1888. The question of further improvement was considered by a Board of Engineer Officers, who submitted a report under date of January 16, 1889. The conclusions of the Board were that the construction of lateral canals on the Illinois side of the river, as proposed by the Business Men's Association of Moline, was not expedient, and that such further improvement of the rapids as was justified by present interests of commerce could best be given at the present time by a further improvement of the natural channel.

Projects and allotments for work under this title of appropriation were submitted and approved, as follows:

1. New plant	$19,000
2. Improvement of Mississippi River from St. Paul to Prescott, by days' labor and Government plant	65,000
3. Improvement of Mississippi River in vicinity of Crooked Slough, by days' labor and Government plant	5,000
4. Improvement of Mississippi River between Read's Landing and Fountain City, by contract	50,000
5. Improvement of Mississippi River between Fairport and Muscatine, by contract	50,000
6. Improvement of Mississippi River in vicinity of Keithsburgh, by contract	50,000

7. Improvement of Mississippi River in vicinity of Fort Madison, by contract	$35,000
8. Improvement of the Mississippi River at the head of Lake Pepin, by days' labor and Government plant	65,000
9. Operations of one Government plant in the vicinity of Winona and at other points	50,000
10. Operations of one Government plant in the vicinity of Pontoosac and at other points	50,000
11. Operations of Dredges Nos. 1 and 3, and attending tow-boats, cutting temporary channels, etc	16,000
12. Surveys	10,000
13. Repairs of plant	15,000
14. Improvement of Rock Island Rapids	40,000
Total	330,000

No project has yet been submitted for work between Minneapolis and St. Paul, but funds are reserved for such work as it may be practical to carry out in the interest of navigation. A survey of this section of the river was made under the direction of Maj. C. J. Allen, Corps of Engineers, in 1887, and a report upon such survey was submitted by him under date of December 29, 1887. It is understood that Congress, by an act approved March 3, 1873, adopted, as a plan for the partial improvement of the river between Minneapolis and St. Paul, the construction of a lock and dam at Meeker's Island, and it would appear that this plan of slack-water improvement is the only one practicable for the radical improvement of the river above Minnehaha Creek. Between the mouth of the Minnesota and St. Paul the river is now about as good as it is below St. Paul. It is suggested by Major Allen that the upper portion of the channel between Minneapolis and St. Paul can be improved to a limited extent by the dredging of sand, gravel, and broken rock, and the removal of bowlders. Detailed examinations, looking to the carrying out of so much work as may be justified by the interests involved, will be made as soon as practicable.

Contracts for work under approved projects were made during the year as follows:

1. With Patterson Brothers for the construction of dams and shore protections in the vicinity of Fort Madison, Iowa.
2. With A. J. Whitney for constructing dams and shore protections in the vicinity of Keithsburgh, Ill.
3. With A. J. Whitney for construction of dams and shore protections between Fairport and Muscatine, Iowa.
4. With A. J. Whitney for construction and repair of dams and shore protections between Read's Landing, Minn., and Fountain City, Wis.

Work in the vicinity of Fort Madison was commenced April 8, 1889, and is now almost completed. Work between Fairport and Muscatine and in the vicinity of Keithsburgh has just been commenced. Work between Read's Landing and Fountain City will be commenced early in July.

Work between St. Paul and Prescott was resumed April 21, 1889, by days' labor and Government plant, and has been carried on rapidly and successfully under the immediate supervision of J. D. Dushane, United States superintendent.

Work in the vicinity of Pontoosac was commenced April 20, 1889, by days' labor and Government plant, and has been vigorously prosecuted under the supervision of S. Edwards, overseer.

Work in the vicinity of Winona, owing to delay in repairs of tow-boat *Alert*, was not commenced until May 27, 1889, but since that date good progress has been made under the superintendence of W. A. Thompson, United States superintendent. The amount of work imme-

diately necessary in the vicinity of Winona proving not as great as was anticipated, the Government plant now working there will soon be transferred to some other point.

Work on the Rock Island Rapids, under the immediate direction of J. C. McElherne, United States superintendent, was commenced May 14, 1889. Dredge No. 1, a drill-boat, and launch *Louise* and barges are employed on this work.

Preparations have been made for commencing the work at the head of Lake Pepin early in July. The channel at this point being now better than in former years, it is not expected that the full allotment made for this locality will be expended this season.

Work in the vicinity of Crooked Slough, consisting in the repair of existing dams and shore protections and the extension of the latter, was commenced April 2 and suspended May 9, 1889.

The snag-boat *J. G. Parke* and dredge *Phœnix* were employed during the present season dredging temporary channels in the vicinity of Dallas and Pontoosuc and above Wabasha, and in furnishing gravel for dam construction.

Summaries of work carried on during the present season under the appropriation for "Improving Mississippi River from Minneapolis to Des Moines Rapids" are given in the appended reports of Assistant Engineer C. W. Durham and U. S. Civil Engineer M. Meigs. Full reports on these works will, as usual, be given in the subreports for the calendar year, which will accompany my next annual report.

FACILITATING NAVIGATION THROUGH BRIDGES OVER THE UPPER MISSISSIPPI RIVER, BETWEEN MINNEAPOLIS AND KEOKUK, UNDER SECTION 8, RIVER AND HARBOR ACT OF JULY 5, 1884, AND SECTIONS 9 AND 10 OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

No new bridges have been constructed during the past year. Correspondence has been carried on with several of the bridge companies regarding further improvements for facilitating navigation through draw and raft spans. The changes in McGregor ponton bridge, referred to in last report, have been made, and the only work remaining to be done at this point is the removal of a few piles and the construction of booms. Under date of March 25, 1889, the Secretary of War formally approved of certain work voluntarily done by the Chicago, Milwaukee and St. Paul Railway Company in 1885–'86, in connection with the bridge at Hastings, Minn. Under the provisions of the act of August 11, 1888, the Secretary of War, under date of December 19, 1888, formally notified the Keokuk and Hamilton Bridge Company to so alter the bridge at Keokuk, Iowa, as to render navigation through it free, easy, and unobstructed, prescribing that the work should be completed on or before March 31, 1889. No action has yet been taken by the company.

GENERAL REMARKS.

The stage of water during the year 1888 was favorable for the interests of navigation, the river reaching during that year, at many points, its highest well-authenticated stage. During the year 1889 the river has been remarkably low, owing to the absence of snow last winter and a scarcity of the usual spring rains. It is possible that the river during the coming fall may reach the low-water mark. During the low-water season of this year the benefits derived from the work already carried out by the Government have been very apparent. Navigation at most of the points where formerly much trouble was experienced has been

comparatively easy and unobstructed. Whatever trouble has been experienced so far this season has been at points where the channel has not yet been properly regulated.

During the present season the Mississippi River Logging Company, being unable to make full use of their rafting grounds in Beef Slough, have run loose logs in the Mississippi from the mouth of the Chippewa to the head of West Newton Slough, a distance of about 10 miles. This has been very annoying to the other interests of navigation, and it is to be hoped that such occupation of a portion of the Upper Mississippi River is but temporary. If this running of loose logs in the Mississippi River is proper and to be permanently continued, it would appear questionable whether it is desirable for the Government to continue its work of improvement between Read's Landing and Alma, and unfortunately this section of the Upper Mississippi, owing to excessive width and amount of sand brought in by the Chippewa River, is, even without the additional obstruction caused by loose logs, one of the most troublesome and difficult to improve of any between St. Paul and the Des Moines Rapids.

As has been heretofore expressed, it is desirable, if the radical improvement of the Upper Mississippi River is to be continued and carried to a successful completion, that it should be carried on under liberal appropriations. As an amount that can be expended during the fiscal year ending June 30, 1891, I would submit an estimate $1,500,000. It will be remembered that this is an estimate for carrying on work over about 500 miles of river, all of which will in time require improvement, and though the estimate is apparently for one work it covers a large number of works, which, while belonging to one system, are in fact independent of each other. In giving the amount that can be expended in one year it is understood that the economical and proper expenditure of such a sum must be preceded by adequate preparation. Such preparation requires time and can not be made till the means of carrying on the work are in sight.

Commercial statistics relating to the Upper Mississippi River are given in connection with the report on "Operating snag-boats and dredge-boats on the Upper Mississippi River." These statistics do not in any sense indicate the relations of this work to the interests of commerce and the general public. The influence which the Upper Mississippi in an improved condition has upon freight rates must be taken as a measure of its importance.

The existing project for this work is one of general methods and plans rather than details. No definite estimate of cost of completion can well be given. Projects for the expenditure of each appropriation, in accordance with approved plan and methods, are presented in lieu of a general project for completion of work.

SUMMARY OF EXPENDITURES FOR CALENDAR YEAR ENDING DECEMBER 31, 1888.

St. Paul to Prescott	$23,620.23
West Newton Bar	5,402.84
Vicinity of Fountain City	8,855.37
Otter Island to Nauvoo	4,676.16
Buoys on Rock Island Rapids	1,121.70
Snag-boat *General Barnard*	1,443.94
Surveys and gauges	12,068.28
Purchase, care, and repair of plant	20,650.20
Total (general improvement)	77,838.72
Harbor at Lake City (allotted by act of July 5, 1884)	1,529.65
Practical test of Adams's flume (allotted by act of August 5, 1886)	72.00
Net expenditure	79,440.37

GENERAL STATEMENT OF RECEIPTS AND EXPENDITURES.

Expended by vouchers from commencement of improvement to July 1, 1889:		
For general improvement:		
St. Paul to Des Moines Rapids		*$1,562,096.50
Minneapolis to Des Moines Rapids		142,901.63
For harbor at Lake City, St. Paul to Des Moines Rapids		12,484.17
For practical test of Adams's flume, St. Paul to Des Moines Rapids		†22,176.83
Total		1,739,659.13
Deduct amount received from sales of fuel	$943.68	
Deduct amount received from sale of rock	1,078.05	
		2,021.73
Net cost of improvement		1,737,637.40
Balance July 1, 1889:		
St. Paul to Des Moines Rapids	†‡2,764.23	
Minneapolis to Des Moines Rapids	457,098.37	
		459,862.60
Total appropriated		*2,197,500.00

ABSTRACT OF APPROPRIATIONS.

St. Paul to Des Moines Rapids:	
By act approved—	
June 18, 1878	$250,000
March 3, 1879	100,000
June 14, 1880	150,000
March 3, 1881	200,000
By act passed August 2, 1882	250,000
By act approved—	
July 5, 1884 (general improvement)	250,000
July 5, 1884 (applied to harbor at Lake City)	15,000
August 5, 1886	382,500
Minneapolis to Des Moines Rapids:	
By act of August 11, 1888	600,000
Total	2,197,500

Net expenditures on the various sections of the river between Minneapolis and Des Moines Rapids from commencement of improvement to July 1, 1889.

Locality.	Distance.	Amount.
	Miles.	
Minneapolis to St. Paul (Omaha Bridge)	11	
St. Paul (Omaha Bridge) to Prescott	33	$430,282.44
Prescott to head of Lake Pepin	29	85,830.00
Harbor at Lake City		12,484.17
Foot of Lake Pepin to Alma	13	187,379.96
Alma to Winona Bridge	29	221,081.09
Winona Bridge to La Crosse Bridge	31	83,623.92
La Crosse Bridge to McGregor Bridge	73	85,604.74
McGregor Bridge to Dubuque Bridge	59	81,251.19
Dubuque Bridge to Clinton Bridge	67	49,752.96
Clinton Bridge to Rock Island Bridge	40	37,773.48
Rock Island Bridge to Keithsburgh Bridge	58	41,009.39
Keithsburgh Bridge to Des Moines Rapids	60	223,321.39
Surveys, gauges, and meter-work		37,696.10
Snag and dredge boats and wrecking		30,480.67
Facilitating navigation through bridges		1,201.12
Plant at estimated value		37,138.67
Practical test of Adams's flume		22,176.83
Total		1,737,637.40

*This amount includes $1,354.50 heretofore reported "For office Chief of Engineers."

†In addition to this amount Mr. Adams expended $8,000, appropriated by act of August 2, 1882, as a separate item.

‡Of this amount $2,515.83 pertain to Lake City Harbor, $215.65 are non-payments on account of general improvement, and $32.75 are non-payments on account of practical test of Adams's flume.

FINANCIAL STATEMENTS.

1. *General improvement.*

July 1, 1888, amount available		$62,210.76
Amount appropriated by act of August 11, 1888		600,000.00
Received from sale of fuel		111.04
		662,321.80
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$204,975.03	
July 1, 1889, outstanding liabilities	4,746.49	
July 1, 1889, amount covered by existing contracts	92,275.07	
		301,996.59
July 1, 1889, balance available		360,325.21

2. *Allotment for practical test of Adams's Flume.* (*Act of August* 5, 1886.)

July 1, 1888, amount available		$67.05
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$34.30	
July 1, 1889, outstanding liabilities	32.75	
		67.05

3. *Applied to Lake City, Minn.* (*Act of July* 5, 1884.)

July 1, 1888, amount available		$3,014.77
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888		498.94
July 1, 1889, balance available		2,515.83

ST. PAUL TO DES MOINES RAPIDS.

Money statement.

July 1, 1888, amount available		$65,225.53
Received from sales of fuel		111.04
		65,336.57
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$62,572.34	
July 1, 1889, outstanding liabilities	248.40	
		62,820.74
July 1, 1889, balance available		2,515.83

MINNEAPOLIS TO DES MOINES RAPIDS.

Money statement.

Amount appropriated by act of August 11, 1888		$600,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$142,901.63	
July 1, 1889, outstanding liabilities	4,498.99	
July 1, 1889, amount covered by existing contracts	92,275.07	
		239,674.79
July 1, 1889, balance available		360,325.21

Amount that can be profitably expended in fiscal year ending June 30, 1891 ..... 1,500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., March 20, 1889, at 2 p. m., for construction of dams and shore protections of brush and stone between Fairport and Muscatine, Iowa.

No.	Name and address of bidder.	Stone in place, 20,000 cubic yards.		Brush in place, 20,000 cubic yards.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Coleman Brothers, Davenport, Iowa	$1.25	$25,000	$0.40	$8,000	$33,000
2	A. J. Whitney, Rock Island, Ill	1.15	23,000	.40	8,000	31,000
3	Fruin Bambrick Construction Company, St. Louis, Mo	1.25	25,000	.70	14,000	39,000
4	Thomas G. Isherwood, Le Claire, Iowa	1.23	24,600	.50	10,000	34,600
5	George Lamont, Rock Island, Ill	1.40	28,000	.55	11,000	39,000
6	Dodge, Halbert & Co., Buffalo, Iowa	1.19½	23,900	.67½	13,500	37,400
7	Sid. J. Truax, Hastings, Minn	1.24	24,800	.65	13,000	37,800
8	Albert Kirchner, Fountain City, Wis	1.20	24,000	.57	11,400	35,400
9	Jacob Richtman, Fountain City, Wis	1.44	28,800	.63	12,600	41,400
10	Conrad Eimbeck, Keokuk, Iowa	1.35	27,000	.65	13,000	40,000
11	Patterson Brothers, Keokuk, Iowa	1.20	24,000	.40	8,000	32,000
12	George H. Schafer, Fort Madison, Iowa	1.40	28,000	.70	14,000	42,000
13	Peter McGee, St. Charles, Mo	1.19½	23,900	.60	12,000	35,900
14	H. S. Brown, Quincy, Ill	1.10	22,000	1.00	20,000	42,000
15	Charles H. Appleton, Quincy, Ill	1.65	33,000	.85	17,000	50,000

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., March 20, 1889, at 2 p. m., for constructing brush and stone dams and shore protections in vicinity of Keithsburgh, Ill.

No.	Name and address of bidder.	Stone in place, 20,000 cubic yards.		Brush in place, 20,000 cubic yards.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Coleman Brothers, Davenport, Iowa	$1.54	$30,800	$0.40	$8,000	$38,800
2	A. J. Whitney, Rock Island, Ill	1.20	24,000	.40	8,000	32,000
3	John Loftus and Charles A. Cameron, Burlington, Iowa[a]	1.54	30,800	1.24	24,800	55,600
4	Fruin Bambrick Construction Company, St. Louis, Mo	1.50	30,000	.85	17,000	47,000
5	George Lamont, Rock Island, Ill	1.60	32,000	.55	11,000	43,000
6	Fisher, Koehler & Co., Muscatine, Iowa	1.75	35,000	.70	14,000	49,000
7	Albert Kirchner, Fountain City, Wis	1.50	30,000	.70	14,000	44,000
8	Sid. J. Truax, Hastings, Minn	1.49	29,800	.70	14,000	43,800
9	Jacob Richtman, Fountain City, Wis	1.53	30,600	.63	12,600	43,200
10	Conrad Eimbeck, Keokuk, Iowa	1.45	29,000	.68	13,600	42,600
11	Patterson Brothers, Keokuk, Iowa	1.75	35,000	.85	17,000	52,000
12	George H. Schafer, Fort Madison, Iowa	1.40	28,000	.70	14,000	42,000
13	H. S. Brown, Quincy, Ill	1.60	32,000	.75	15,000	47,000
14	Peter McGee, St. Charles, Mo	1.38¾	27,700	.64½	12,900	40,600

[a] Informal guaranty incomplete.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ills., March 20, 1889, at 2 p. m., for construction of dams and shore protections of brush and stone in vicinity of Fort Madison, Iowa.

No.	Name and address of bidder.	Stone in place, 14,000 cubic yards.		Brush in place, 14,000 cubic yards.		Grand Total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	A. J. Whitney, Rock Island, Ill	$1.19	$16,660	$0.50	$7,000	$23,660
2	B. Lantry & Sons, Fort Madison, Iowa	1.45	20,300	.75	10,500	30,800
3	Fruin Bambrick Construction Company, St. Louis, Mo	1.45	20,300	.85	11,900	32,200
4	George Lamont, Rock Island, Ill	1.50	21,000	.55	7,700	28,700
5	Albert Kirchner, Fountain City, Wis	1.35	18,900	.70	9,800	28,700
6	Jacob Richtman, Fountain City, Wis	1.44	20,160	.63	8,820	28,980
7	Sid. J. Truax, Hastings, Minn	1.25	17,500	1.00	14,000	31,500
8	Patterson Brothers, Keokuk, Iowa	1.20	16,800	.40	5,600	22,400
9	Conrad Rimbeck, Keokuk, Iowa	1.25	17,500	.70	9,800	27,300
10	George H. Schafer, Fort Madison, Iowa	1.14	15,960	.70	9,800	25,760
11	H. S. Brown, Quincy, Ill	1.15	16,100	.65	9,100	25,200
12	Charles H. Appleton, Quincy, Ill	1.95	27,300	.85	11,900	39,200

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., March 20, 1889, at 2 p. m., for construction and repair of dams and shore protections of brush and stone between Read's Landing, Minn., and Fountain City, Wis.

No.	Name and address of bidder.	Stone in place, 22,000 cubic yards.		Brush in place, 18,000 cubic yards.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	A. J. Whitney, Rock Island, Ill	$1.30	$28,600	$0.50	9,000	$37,600
2	Clarence Jellison, Wabasha, Minn	1.20	26,400	.95	17,100	43,500
3	Albert Kirchner, Fountain City, Wis	1.24	27,280	.69	10,800	38,080
4	Sid. J. Truax, Hastings, Minn	1.49	32,780	.50	9,000	41,780
5	Jacob Richtman, Fountain City, Wis	1.26	27,720	.63	11,340	39,060
6	Patterson Brothers, Keokuk, Iowa	1.55	34,100	.85	15,300	49,400
7	Charles H. Appleton, Quincy, Ill.*	1.65	36,300	.85	15,300	51,600

*Informal seals wanting.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 1, 1889.

MAJOR: I have the honor to submit the following report of operations for the improvement of the Mississippi River in the division under my charge, extending from St, Paul, Minn., to the vicinity of Burlington, Iowa, for the calendar year ending December 31, 1888:

ST. PAUL TO PRESCOTT.

Operations were carried on by hired labor and purchase of material in open market and the use of portions of plants 1 and 2 and at different times of United States towboat *Fury* and steam-launches *Louise*, *Stella*, and *Bessie*.

Details of this important work are given in the following extracts from the season's report of Mr. J. D. DuShane, superintendent in local charge:

* * * * * * *

"At the time of resuming operations for the season of 1888, September 10, the condition of the river was good, excepting at Frenchman's Bar, just below St Paul, and at Island 17.

"The bar at Frenchman's had been shoaling gradually for several years, but the special trouble this season was largely caused by dumping into the river the city

refuse, consisting of street sweepings, garbage, etc., from the barges of the Sanitation Company, which contracted with the city of St. Paul for the removal of all refuse matter from the city limits. This company seems not to have confined the depositing of this material to any particular place, but apparently dumped it wherever it best suited its convenience. This practice was continued until the shores of the river became excessively foul, 'creating a most noxious atmosphere, proving a nuisance to the inhabitants of the city of South St. Paul,' which early in August brought suit against the company, and secured an injunction restraining it from depositing 'garbage and other noisome material' in the river or along its banks in the vicinity of South St. Paul. The company then changed its place of deposit and pretended to use the lower end of Pig's Eye Slough for a dumping ground. While some deposits of this material was made in the slough (a great part of which was immediately carried by the current out into the river), much was unloaded directly into the river below the slough. On several occasions overloaded barges grounded on Frenchman's Bar, where they were left until darkness covered the company's actions from public gaze while unloading the stuff into the river. Much of this material settled on the bottom, forming lumps in the channel, which proved serious obstacles to navigation. Some idea of the enormous quantity of city refuse deposited in the river may be had when it is stated that 500 tons per day are dumped in from Minneapolis below the falls, and the quantity from St. Paul is probably equal to or greater than this, as Minneapolis has a crematory with a capacity of 200 tons per day, while the entire quantity collected in St. Paul goes into the river. Supposing 1,000 tons per day deposited by the two cities during seven months in the year, and that 1 ton will make 1 cubic yard in bulk (it will make much more), sufficient material to completely fill the river-bed to a plane 1 foot above low water of 1864 from St. Paul to the St. Croix River, a distance of 30 miles, would be deposited in about twenty-five years.

"At time of resuming operations for the season of 1888 the bar at Island 17 gave the most trouble, and on September 10 work was begun at this place. Dams 28 and 28½ (sheet 5) were built between Dams 18 and 19, and Dam 18 was lengthened 100 feet and raised to 4.5 feet above low-water. While this work was in progress the dredge *Phœnix* arrived, and on September 14 began casting a temporary cut through the bar; this cut started at the reef of bar about 100 feet out from Dam 19 and inclined upstream toward the head of Island 17. After Dams 28 and 28½ had been built across what little channel existed this cut afforded passage for boats until a better opening could be secured along the shore of Island 17, where it was designed the permanent channel should form. On September 21 a cut was begun near the foot of Island 17. The dump-boats, being now available, the dredged material was carried beyond the channel limits and deposited near shore between the dams. By the 23d, as a result of the dams built and the removal of a part of the moving sand from the channel by the dredge, a passage 100 feet wide and 4 feet deep was secured. At this stage of operations it was thought best to let the increased velocity of the current continue the improvement, and the dredge was withdrawn and sent to Frenchman's Bar. Work on the dams was finished September 26, and the fleet was towed to Frenchman's for further operations. By the middle of October the channel at Island 17 had become wide and straight, with a depth of water of 5.5 feet.

"At Frenchman's the dredge started casting a cut through the bar on September 25. On the 27th Dams 31 and 32 (sheet 1) were begun. Dredging operations continued until October 13, by which time a cut was made 1,500 feet long, 40 feet wide at upper end, and 75 feet wide at lower end, having a clear depth of 5 feet of water. These operations consisted of one cut cast into a bank 1,500 feet long, one cut 800 feet, and one cut 200 feet long, the material from the last two cuts being removed in dumps and the greater part deposited beyond the channel limits. The material dredged was a mixture of coarse sand, small gravel, and mill refuse. The construction of dams and bank revetment was continued until November 3. During this time there were built Dams 16, 17, 18, 19, and 20 (sheet 1) from the left bank; Dams 31, 32, 33, 34, and 35 (sheet 1) from the right bank were partially completed; and the left bank for a distance of 2,200 feet between Dams 19 and 20 was protected. On account of the scarcity of material but a slight covering of rock was used on this revetment. Owing to the large volume of sand within the channel limits, which it was not desirable to set in too rapid motion, the dams from the right bank were not built to their full length; these dams, 31 to 35 inclusive, should be completed during the season of 1889.

"The rock patch below Grey Cloud Landing was removed between October 15 and 18 by dredging. The material consisted of a mixture of bowlders (many of them 2 to 3 feet in diameter), gravel, sand, and clay; it was deposited on line of prolongation of Dam 10 (sheet 5). All rocks that could be found were removed. There seem to be gravel deposits at each end of the rock patch, that at the upper end apparently being a continuation of the gravel point on shore above; the top of the gravel, except near the shore above, is 3 feet below low water of 1864; a thorough sounding of these deposits was made, but no bowlders were found.

"From October 19 to 22 the dredge operated at the month of Boulanger Slough, deepening the passage to the quarries and winter harbor of the Government fleet, and removing rocks from the river-bed blown in from the quarries below the slough. October 23 the dredge was transferred to Mr. W. A. Thompson, U. S. superintendent.

"November 3 the plant was taken to the vicinity of Island 16, and Dams 29 and 30 (sheet 5) were built—Dam 29 from the right bank below Dam 19, and Dam 30 from the left bank below Dam 25; Dam 31 (sheet 5) from the left bank below Dam 30 was partly completed, being left unfinished on account of materials being exhausted at close of season. Dams 16, 17, 19, 20, 21, 22, 23, and 25 (sheet 5) were raised to 4.5 feet above low water, and Dams 19, 20, and 21 were lengthened 50 feet each; Dam 1 (sheet 5) was repaired, the repairs consisting of 30 feet of new dam, a new shore protection where the east bank was washed out, and a course of brush and rock over the entire length of dam. Slight repairs were made to the revetment of Island 13.

"Operations were suspended November 15, and the plant was put in winter quarters in Boulanger Slough on the 16th.

"Works of improvement should be constructed during the season of 1889 at the following places, or so much thereof as time and funds will permit; all of these works form part of the general system projected for the permanent completion of the stretch of river under consideration: The completion of the series of dams from St. Paul to Pig's Eye; of these Dams 28 and 30 should be omitted, and Dams 27 and 29 should be constructed with a training-wall at outer ends (similar to Dam 4, sheet 1); the construction of revetment on right bank at Pig's Eye; a few short dams from right bank at Kaposia; dams from left bank in the vicinity of, and revetment of right bank below, Pine Bend; dams in continuation of the series opposite Island 15; revetment of right bank below Hastings.

"Repairs should be made at the following places: Dams in the vicinity of Kaposia; dams opposite Newport; revetment above Robinson's Rocks; Dam 11 (sheet 4); dams in the vicinity of Island 15; Dams 1 and 2 (sheet 5) need rock covering; revetment opposite Nininger."

LIST OF WORKS CONSTRUCTED AND REPAIRED, AND OF MATERIALS USED DURING SEASON OF 1888, BETWEEN ST. PAUL AND PRESCOTT.

Works.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
	Feet.	*Feet.*	*Cubic yards.*	*Cubic yards.*
Sheet 1:				
Dam No. 16	90	4.5	135.7	408.0
Dam No. 17	150	4.5	181.6	458.0
Dam No. 18	240	4.5	228.2	840.2
Dam No. 19	135	4.5	222.1	628.3
Dam No. 20	175	4.5	127.9	425.0
Dam No. 21	400	4.5	460.9	1,368.5
Dam No. 22	500	4.0	462.9	1,099.9
Dam No. 23	600	4.0	479.2	1,057.4
Dam No. 24	600	4.0	649.6	1,490.9
Dam No. 25	450	4.5	693.0	1,107.0
Revetment below Dam No. 19	2,200	.....	1,800.4	2,027.5
Sheet 4:				
Revetment below Island 13, repairs	.....	.....	120.2	.....
Sheet 5:				
Dam No. 28	450	4.5	663.9	1,597.7
Dam No. 28½	480	4.5	915.1	2,008.0
Dam No. 29	300	4.5	300.9	806.7
Dam No. 30	140	4.5	247.8	650.9
Dam No. 31	180	.....	131.0	473.1
Dam No. 1, repairs and extension	30	.....	335.1	640.6
Dam No. 16, raised	.....	4.5	173.2	177.3
Dam No. 17, raised	.....	4.5	125.5	149.1
Dam No. 18, raised and extended	100	4.5	372.3	611.4
Dam No. 19, raised and extended	50	4.5	302.4	697.4
Dam No. 20, raised and extended	50	4.5	158.7	261.0
Dam No. 21, raised and extended	50	4.5	126.8	307.0
Dam No. 22, raised	.....	4.5	133.3	247.7
Dam No. 23, raised	.....	4.5	83.8	152.9
Dam No. 25, raised	.....	4.5	128.8	239.9
Total	.....	.....	9,754.4	19,571.4
Add for 14,400 poles put in works, cubic yards	.....	.....	.....	480.0
Cubic yards of materials put in works	.....	.....	9,754.4	20,051.4

The materials were purchased in open market at the following prices: Rock on barges, 45 to 47 cents per cubic yard; brush on barges, 26 cents per cubic yard; poles on barges, 3 cents each.

FINANCIAL STATEMENT FOR WORKS OF IMPROVING MISSISSIPPI RIVER BETWEEN ST. PAUL AND PRESCOTT DURING THE SEASON OF 1888.

Amount expended in the field for the calendar year 1888 (from distribution sheets)	$19,822.34
Add proportion of general superintendence and office expenses	3,797.89
Add for use and deterioration of plant	10,251.08
Total cost of works	33,871.31
Cubic yards of material put in works:	
Brush and poles	20,051.4
Rock	9,754.4
Total	29,805.8
Average cost per cubic yard of material in place	1.136
Average cost per cubic yard of material in place, exclusive of plant charge, but including general superintendence and office expenses	0.793
Average cost per cubic yard of material in place, exclusive of general superintendence, office, and plant charges	0.665
Average cost per cubic yard of material on barge	0.328
Average length of tow of material, miles	15.9
Average cost per cubic yard of towing and putting in material	0.337

VICINITY OF FOUNTAIN CITY, WISCONSIN.

The bar at this locality was very troublesome in 1887; in fact, more so than any other between Des Moines Rapids and St. Paul. The project for work at Fountain City was submitted March 29, 1888, and approved April 4, 1888. It proposed the construction of three wing-dams extending from Island 60, nearly opposite the upper end of the village, and contracting the water-way at the bar at a 4-feet stage to about 800 feet, and some small repairs to the ends of Dams 1, 2, 6, and 19 (sheet 17).

The work was performed by day's labor and purchase of material in open market, steam launch *Louise* and eight barges being used for transportation of the material.

Operations commenced June 14 on Dam 26, the upper one of the series. It was completed June 28, is 620 feet in length, and has its crest at an elevation of about 5 feet above low water of 1864. Dam 27 was built between June 28 and July 7, is 490 feet long, and at an elevation of 4½ feet above low water. Dam 28, the lowest of the series, which is 380 feet long and 4 feet above low water, was completed July 18. Some slight repairs to ends of Dams 1, 2, and 19 were made, and the fleet laid up on the 21st of July. At the close of the work a marked increase in the depth on the bar was observed. A small amount of work will be needed in 1889 in constructing a short wing-dam below Dam 28 and leveling up the dams built in 1888.

List of works constructed and repaired, and of materials used during season of 1888, in vicinity of Fountain City, Wis.

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
Sheet 17:	*Feet.*	*Feet.*	*Cubic yards.*	*Cubic yards.*
Wing-dam 26	620	5.0	2,070.2	1,870.1
Wing-dam 27	490	4.5	1,446.3	1,612.9
Wing-dam 28	380	4.0	1,346.2	1,231.0
Dams 1, 2, and 19, repairs	.....	.....	202.0	381.0
Total	1,490	.....	5,064.7	5,195.0

Material was purchased in open market at the following prices: Rock on barges, 64½ cents per cubic yard; brush on barges, 25 cents per cubic yard; poles, 2½ cents each.

FINANCIAL STATEMENT FOR WORKS IN THE VICINITY OF FOUNTAIN CITY, WISCONSIN, DURING THE SEASON OF 1888.

Amount expended in the field during the calendar year 1888 (from distribution sheets)	$7,431.59
Add value of brush brought over from season of 1887	64.40
	7,495.99
Deduct value of brush carried to West Newton Bar	97.50
Cost of field work	7,398.49
Add quota of general superintendence and office expenses	1,423.78
Add for use and deterioration of plant	3,843.07
Total cost of work	12,665.34
Material put in works:	
Rock, cubic yards	5,064.7
Brush, cubic yards	5,195.0
Total, cubic yards	10,259.7
Average cost per cubic yard of material in place	1.234
Average cost per cubic yard of material in place, exclusive of plant charge but including general superintendence and office expenses	.86
Average cost per cubic yard of material in place, exclusive of general superintendence, office, and plant charges	.721
Average cost per cubic yard of material on barge	.452
Average cost per cubic yard of towing and putting in material	.269

WEST NEWTON BAR.

In 1887 and 1888 rafts experienced much trouble in passing the head of Island 46. The difficulty was caused by the existence of a large sand-bar, which encroached on the main channel, and by the draught of water down Pomme de Terre Slough. It was thought that by checking this side draught the trouble would be lessened, and that by degrees the bar would be cut away and afford a wider passage. The project for this work, forwarded August 1, 1888, proposed the raising and reparing of the dams at the head of Pomme de Terre Slough and of some of those between Alma and West Newton Bar, an allotment of $5,000 being made for field work.

The work was performed by day's labor and purchase of material in open market; steam-launches *Louise* and *Stella* and nine barges being used for transportation of material.

Operations began July 30, 1888, and were completed August 24, when the fleet was towed to the Wabasha boat-yards, for repairs, by snag-boat *General Barnard*.

The first work undertaken was the raising and repairing of Dams 1 and 2 (sheet 15). This work, which was attended with some difficulty owing to shallow water and lack of suitable moorings, was completed August 15, the crest of the dams having been raised to an elevation of 6 feet above low water. By means of this work the strong draught of water down the chute was completely checked, and a channel was developed through the bar which it is thought will soon be wide and deep enough for the purposes of navigation. To re-enforce the work above mentioned Dam 6, closing a small cut-off, was raised and strengthened, and the shore above, a portion of which was low and marshy, was protected for a distance of 986 feet. A small quantity of rock was placed on the head of Island 45 and on Dam 3 and shore protection below.

List of works constructed and repaired and of materials used during season of 1888 *at West Newton Bar.*

Designation.	Rock.	Brush.
Sheet 15:	*Cubic yards.*	*Cubic yards.*
Dams 1 and 2, repairs, etc	1,838.0	861
Shore protection above Dam 6, 986 feet	1,221.1	852
Shore protection below Dam 3, repairs	94.2	.....
Total	3,153.3	1,713

Material was purchased in open market at the following prices: Rock on barges, 73.8 cents per cubic yard; brush on barges, 25 cents per cubic yard; poles on barges, 2½ cents each.

FINANCIAL STATEMENT FOR WORKS IN THE VICINITY OF WEST NEWTON BAR DURING THE SEASON OF 1888.

Amount expended in the field during the calendar year 1888 (from distribution sheets)	$4,534.13
Add value of brush brought up from Fountain City	97.50
Cost of field-work	4,631.63
Add quota of general superintendence and office expenses	868.71
Add for use and deterioration of plant	2,344.47
Total cost of work	7,844.81
Material put in works:	
Rock, cubic yards	3,153.3
Brush, cubic yards	1,713.0
Total, cubic yards	4,866.3
Average cost per yard of material in place	1.612
Average cost per cubic yard of material in place, exclusive of plant charge, but including general superintendence and office expenses	1.130
Average cost per cubic yard of material in place, exclusive of general superintendence, office, and plant charges	.952
Average cost per cubic yard of material on barge	.561
Average cost per cubic yard of towing and putting in material	.391

The nature of the work requiring a great excess of rock—the more expensive material—largely increased the average cost per cubic yard of material in place.

BUOYAGE OF ROCK ISLAND RAPIDS.

During the spring of 1888 15 new buoys were purchased, to replace those lost, water-logged, and worn out, and the same number of sets of bolts and chains. On April 7 the tow-boat *Fury*, assisted by steam-launch *Stella* and drill-boat, began replacing the buoys. The work was much delayed by bad weather and the high stage of water prevailing, but was completed April 14. All the range stakes were carefully looked up, reset and changed where necessary, and repainted. The old mooring chains were found by means of the ranges at Nos. 1, 2, 3, 5, 6, 7, 9, 9½, 10, 11, 12, 12½, 13, 15, 16, 17, 17½, 18, 19, 21, 22, and 24. The chains could not be found at Nos. 4, 8, 14, 20, 23, 25, and 26, and new bolts were set in the rock bottom, excepting at Nos. 4 and 26, where anchors were used. Three new buoys were added to the system, numbered 13½, 16½, and 24½, the total number now being 32. During the season buoys were frequently carried away by rafts, but were as often reset by a rapids pilot. On November 17 and 18 the range stakes were again examined and the buoys were taken up and stored for the winter.

The buoys have proved to be of great value to navigation. The cost of buoyage for the season of 1888, including proportion of plant charges, superintendence, and office expenses, was $1,607.10.

HARBOR AT LAKE CITY, MINNESOTA.

The top of the breakwater at Lake City was considerably damaged by ice in the spring of 1888. Thorough repairs were made in August. Cost of repairs, including quota of office expenses, etc., $1,529.65.

SNAG-BOAT GENERAL BARNARD.

A small allotment was made from the appropriation for "Improving Mississippi River from St. Paul to Des Moines Rapids" for urgent work. Operations are given under head of "Operating snag-boats and dredge-boats on Upper Mississippi River." Amount expended, including quota of office expenses, $1,443.94.

REPAIRS OF PLANT.

During March and April, 1888, tow-boat *Fury* and steam-launches *Louise* and *Stella*, which had been docked at Rock Island in the fall of 1887, were thoroughly repaired and partially repainted at that place. In August, September, and October, 1888, the

following barges were repaired at Prescott, viz: *Nos.* 3, 4, 5, 6, 9, 37, 38, 64, 77, 80, 81, 83, 94, and 95; also quarter-boat *No.* 17 and steam-launch *Bessie*. At Wabasha, in August, September, October and November, 1888, the following barges were thoroughly repaired, viz: *Nos.* 1, 7, 20, 36, 65, 68, 71, 76, 85, 101 and 102; also building-boat *No.* 41, grass-hopper *No.* 42, and dump-boats *Nos.* 5 and 6. Tow-boats *Alert* and *Parke* and dredge *Phœnix* received partial repairs. At La Crosse, in September and October, 1888, the following barges were thoroughly repaired, viz: *Nos.* 8, 10, 11, 12, 14, 22, 23, 75, 97, and 100, and dump-boats *Nos.* 1, 2, 3, and 4. Tow-boat *Vixen* received slight repairs during the season.

Total cost of repairs, including care of watchmen and quota of superintendence and office expenses, $20,650.20.

SURVEYS AND GAUGES.

In January and February, 1888, a party in charge of Mr. C. H. Beuck, inspector, made through the ice an accurate survey of the river bottom at Duck Creek and Moline Chains of the Rock Island Rapids. A full report of this survey may be found in the Report of the Chief of Engineers, 1888, page 1505.

A party in my personal charge was employed during May, 1888, in establishing high-water marks, bench-marks, etc., between St. Paul and the mouth of Missouri River. A preliminary report on this work may befound in Report of Chief of Engineers, 1888, page 1479.

On April 16, 1888, a party in charge of Mr. J. C. McElherne, inspector, took the field for the purpose of making a survey of the river from Fairport to Muscatine. The field-work was completed April 30 and the office work May 30. High water greatly retarded the work, the banks during the latter part of the survey being under water.

In June and July, 1888, a survey in charge of Mr. W. A. Thompson, superintendent, was made of the greater part of the river between Read's Landing and Winona. Work was much interfered with by high water.

October 9 to 17, 1888, an examination of the vicinity of the head of Lake Pepin was made, and between October 22 and 30, 1888, of a portion of the river in vicinity of Winona.

Maps and tracings of all the above-mentioned surveys have been completed.

Gauges were kept at Hastings, Red Wing, Prairie du Chien, and Winona during the year. Gauge records were also obtained from the Signal Service and the bridge-keepers at St. Paul, Dubuque, Rock Island, Keokuk, Burlington, Quincy, Hannibal, and Louisiana. These records have been plotted.

Amount expended on surveys and gauges during the year, including the surveys made in vicinity of Keithsburgh and between Burlington and Montrose, in charge of Mr. M. Meigs, United States civil engineer, $12,068.28.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, May 1, 1889.

MAJOR: I have the honor to submit the following report of work done under my supervision, between Otter Island and Nauvoo, during the calendar year ending December 31, 1888:

SHORE PROTECTIONS ON ISLAND 395.

September 19, 1888, Mr. S. Edwards, overseer, with the steam-launch *Lucia* and barges, began the work of extending shore protection on Island 395, and extended same 360 feet down-stream. This work was finished September 27, 1888. October 10, 1888, 72.93 cubic yards of rock were used in patching up damage caused by ice.

REPAIRS OF DAM 5-62 (VIXEN CHUTE).

The ice had somewhat loosened the crest of this dam, and considerable damage had been done by persons digging holes to haul their skiffs through. The dam was leveled up and the shore protections extended and repaired where necessary. There

were added 95 feet of shore protections to the east side and 65 feet to the west side below the dam. Work was finished September 29, and the fleet was temporarily laid up in the canal.

REPAIRING DAMS NOS. 1-50 AND 2-50 (SHOKOKON).

Between October 16 and 27, 1888, the *Vixen* was employed on this work. Dam No. 1, east, was found in bad condition, the ice having injured the crest of the dam, and the shore protection on the Illinois end was in a critical condition. The gap in the west dam was apparently unchanged from its condition in the fall of 1887. It had not widened beyond the original 150 feet. The junction of Dam No. 1 with the Illinois shore was repaired, and the crest of the dam leveled up with rock that had been pushed over the crest by the ice. The cost per cubic yard of rock towed up by the *Vixen* appears large; but, of course, a great deal of this labor was performed in replacing rock that had been placed on the dam previously.

REPAIRING SHORE PROTECTIONS OF BURLINGTON ISLAND AND SAUERWEIN'S BEND.

October 29, 1888, repairs were begun on places were the shore protections had slid in, owing to water cutting deep in front of it; also, where damage had been done by ice. Work was finished November 7, 1888.

SHORE PROTECTION NEAR HEAD OF ISLAND 392.

From November 7 to 10, 1888, work was carried on for the protection of a break in the bank near the upper end of island opposite Fort Madison. The water was very shoal and the work was prosecuted under difficulties. About 60 feet of shore protection were put in.

For the above works rock was bought at Nauvoo in open market, at 62.5 cents per cubic yard, on barges. Brush was bought in same way at Montrose, Iowa, at 27 and 28 cents.

November 13, 1888, the *Vixen* was laid up in the canal for the winter.

Statement of work done and cost, exclusive of office expenses and plant charge.

Locality.	Rock.	Brush.	Poles.	Total.	Cost.	Total cost.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Per cu. yd.*	
Island 395	439.31	264.00	13.50	787.81	$0.92	$696.07
Dam 5-62	248.59	53.00	7.50	309.09	1.17	362.55
Dams 1-50 and 2-500	583.83	318.00	.....	901.83	1.34	1,210.84
Burlington Island	850.99	154.00	.....	1,004.99	1.09	1,103.88
Sauerwein's Bend	250.24	.....	.....	250.24	1.44	361.47
Head of Island 392	87.63	.....	.....	87.63	2.15	188.52
Totals	2,561.64	789.00	21.00	3,311.64	1.18	3,924.33

GENERAL STATEMENT OF COST, WITH PLANT AND SUPERINTENDENCE ADDED.

Total expended as per vouchers	$3,924.33
Office expenses added	751.83
Plant charges	2,029.38
Total expense	6,705.54
Total cubic yards	3,311.64
Average cost per cubic yard	$2.02

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1889.

MAJOR: I have the honor to present a preliminary report of operations on the various works in my charge during the second half of the fiscal year ending June 30, 1889.

ST. PAUL TO PRESCOTT.

A project for work between St. Paul and Prescott, under an allotment of $65,000, was submitted January 20, and approved January 26, 1889. The fleet having been put in good condition, operations were commenced April 19, 1889, at Frenchman's Bar, just below St. Paul, and continued at that locality until June 11. There were constructed, or materially lengthened and raised, 20 wing-dams, 1,300 linear feet of training-wall were built, and 1,765 linear feet of shore protection. Considerable work was also done at Kapoeia, below Nininger, and at Robinson's Rocks. The dams and extensions constructed form a total length of 9,325 feet. Amount of material put in—rock, 12,969.06 cubic yards; brush, 31,320.9 cubic yards. This important work as also that at head of Lake Pepin, is in local charge of Superintendent J. D. Dushane.

HEAD OF LAKE PEPIN.

A project for improvement at this locality, under an allotment of $65,000, was submitted February 18, and approved February 28, 1889. A plant has been got ready, and considerable material purchased, but work in the field has not commenced.

READ'S LANDING TO FOUNTAIN CITY.

A project for work under an allotment of $50,000 was submitted February 4, and approved February 11, 1889. The work will be done under contract with A. J. Whitney at $1.30 per cubic yard for rock and 50 cents for brush. It is expected that the contractor will begin operations early in July.

VICINITY OF WINONA AND OTHER POINTS.

An allotment of $50,000 was made for operating an United States plant in vicinity of Winona. The project was submitted February 18, and approved February 28, 1889. Owing to considerable delay experienced in getting the tow-boat *Alert* ready for service, operations were not begun until May 28. They have continued with good progress to the close of the fiscal year. Four dams and about 200 lineal feet of shore protection have been constructed.

VICINITY OF CROOKED SLOUGH.

An allotment of $5,000 was made for raising the dam in Harper Slough and for repairing, strengthening, and extending the shore protections in Crooked Slough. A project was submitted January 28, and approved February 5, 1889. Operations commenced April 1 and were discontinued May 9, 1889. The plant consisted of steam-launch *Louise*, one quarter-boat, and eight barges. In addition to the repairs projected, 660 lineal feet of shore protection were constructed. Material used: Rock, 5,557.2 cubic yards; brush, 695.3 cubic yards.

BUOYS ON ROCK ISLAND RAPIDS.

The buoys were reset March 24 to 29, 1889, by steam-launch *Lucia*. There are thirty-three buoys in the system, twenty-eight of which are secured by bolts and chains to the rock bottom and four are held by anchors. All the range stakes were carefully examined and were reset and changed where necessary.

IMPROVEMENT OF ROCK ISLAND RAPIDS.

The sum of $40,000 was allotted to this work, a project for which was submitted March 6 and approved March 16, 1888. Dredge No. 1 operated from May 15 to June 28, 1889, excavating sand from the channel at head of Campbell's Chain. The dredge worked night and day, and was tended by steam-launch *Louise*. Amount of sand removed, about 31,000 cubic yards. A channel about 300 feet wide and 2,000 feet long has been excavated through the bar.

A steam drill-boat with two drills was put at work May 17, on the dangerous patch of rock in mid-river below Campbell's Chain. The rock proved to be very hard and progress therefore slow. Nearly seven hundred holes, 36 inches deep, were drilled, charged with dynamite, and exploded, resulting in the breaking up of about 460 cubic yards of rock. The drill-boat is still at work on the same ledge.

Dam 8, closing the chute of Campbell's Island, was commenced June 7. Owing to scarcity of barges and insufficient capacity of tow-boat, progress has been slow. One thousand eight hundred and eighty-two and eight-tenths cubic yards of rock have been put in the dam.

FAIRPORT TO MUSCATINE.

A project for work in this locality, under an allotment of $50,000, was submitted February 4 and approved February 11, 1889. The work is being performed under contract with A. J. Whitney, at $1.15 per cubic yard for rock and 40 cents per cubic yard for brush. Operations commenced June 12, 1889. About 1,500 lineal feet of shore protection have been constructed.

VICINITY OF KEITHSBURG.

A project for work in this locality, under an allotment of $50,000, was submitted February 4 and approved February 11, 1889. Contract for the work was made with A. J. Whitney, at $1.20 per cubic yard for rock and 40 cents per cubic yard for brush. Operations will begin early in July, considerable material having been already collected by the contractor.

OPERATIONS OF DREDGE PHŒNIX, CUTTING TEMPORARY CHANNELS.

From May 11 to June 30 the *Phœnix* was employed in deepening the channels at Pontoosac, Dallas, and Wabasha. Good results were obtained. This work is done under an allotment of $16,000, called for in project submitted February 18 and approved February 28, 1889.

REPAIRS OF PLANT.

Considerable repairs were made to tow-boat *Alert* and some small repairs to dredge *Phœnix*, tow-boat *Parke*, and several barges.

SURVEYS.

March 17 to 20, 1889, an examination was made of the bar at head of Campbell's Chain; June 10 to 15, an examination of Cabin and St. Louis Chain rock patches was made and lines of levels were run and water gauges established from Hampton to Watertown.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1889.

MAJOR: I have the honor to present a preliminary report of operations on the various works in my charge for improvement of Mississippi River between Minneapolis and Des Moines Rapids for the second half of the fiscal year ending June 30, 1889.

VICINITY OF FORT MADISON.

A project for work in vicinity of Fort Madison was submitted February 4 and approved February 11, 1889. An allotment of $35,000 was made for the work and the contract let to Patterson Bros. at $1.20 per cubic yard for rock and 40 cents per cubic yard for brush in place. Operations commenced April 8, 1889, on shore protection, west bank of river below Fort Madison, opposite dams 5, 6, and 7 (sheet 61). This shore protection was completed June 13 and is 7,868 feet in length. Dam 6, closing Devil's Island Chute, was begun May 27 and completed early in June. It is 726 feet in length. Dam 7, a wing-dam from Smith's Island, was commenced June 13 and is now nearly completed. Approximate amount of material placed in work: Rock, 17,500 cubic yards; brush, 11,500 cubic yards.

VICINITY OF PONTOOSUC.

The project for this work, comprising the employment of a Government plant under an allotment of $50,000, was submitted February 18 and approved February 28, 1889.

On April 19, 1889, dredge No. 1 was put at work removing snags and stumps from the east shore of Dallas Island, which it was proposed to protect. On April 22 the shore protection on Dallas Island was commenced, and completed June 7. It is 7,260 feet in length, and there were used in its construction 11,283 cubic yards rock, 8,028 cubic yards brush, 5,666 cubic yards gravel. Between June 8 and the end of the month considerable progress was made on wing-dams 11, 12, and 13 (sheet 61).

DREDGING TEMPORARY CHANNELS.

From May 11 to 18, 1889, dredge *Phœnix* was employed in making a cut through Pontoosac Bar. On May 20 she began work on bar opposite head of Dallas Island and continued at that point until June 14, when she was taken north by tow-boat *Parke*. The work at head of Dallas Island gave satisfactory results.

CONSTRUCTION AND REPAIRS OF PLANT.

Repairs were made to most of the barges of plant 4 and also to quarter-boats 45 and 46 and drill-boat 34. Some of the barges were in such bad condition as to require rebuilding. There have been added to the plant, the same being constructed by the Government at the canal, 1 fuel scow, 1 pile-driver, 1 steam drill-boat, 1 magazine scow, and 1 powder-boat. Three steam-launches are now under construction, 1 with steel hull, at Jeffersonville, Ind., and 2 with wooden hulls at the canal. These are nearly ready for service.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

LETTER OF THE SECRETARY OF WAR.

WAR DEPARTMENT,
Washington City, February 2, 1889.

The Secretary of War has the honor to transmit herewith to the House of Representatives, in compliance with the provisions of the river and harbor act of August 11, 1888, a letter of the 31st ultimo from the Chief of Engineers submitting a copy of the report of the Board of Engineer Officers constituted to make an examination and survey of the present channel of the Mississippi River at the Rock Island Rapids, with the view of determining the best and most economical mode of securing a safer channel of greater width and depth, sufficient to meet the necessities of the commerce and navigation of the river, either by the construction of a canal around the rapids on the Illinois side of the river or by widening and deepening the present channel.

It appears that the Board is adverse to the construction of a lateral canal at this time, but is of opinion that the existing navigable channel of Rock Island Rapids should be improved to such an extent as to make the passage over them as reasonably safe by night or day as the natural conditions permit.

The conclusions of the Board in this matter are concurred in by the Department.

WM. C. ENDICOTT,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 31, 1889.

SIR: I have the honor to submit herewith a copy of the report of the Board of Engineer Officers constituted by your direction, in compliance with the requirements of the river and harbor act of August 11, 1888, to make an examination and survey of the present channel of the Mississippi River at the Rock Island Rapids, with the view of determining the best and most economical mode of securing a safer channel of greater width and depth, sufficient to meet the necessities of the commerce and navigation of the river, either by the construction of a canal around the rapids on the Illinois side of the river or by widening and deepening the present channel.

After a full and careful consideration of the subject the Board is of the opinion that the most direct and feasible route, coming within the instructions, for a canal from the head of the rapids to the upper part of Moline, is in the river along the Illinois shore. The location for such a canal is shown on the map accompanying the report, and herewith also transmitted. It would be about 10½ miles long and formed, as in the case of the Des Moines Canal, by embankment in the river, with a width of from 200 to 500 feet, and depth at low water increasing from 6 to 12 feet, having two locks 80 feet wide and 325 feet long. It will be observed that the instructions of the Board do not include a consideration of the Iowa side of the river.

The length of the rapids, from Rapids City to the Rock Island Railroad Bridge, is about 13½ miles, but between Rock Island and the Illinois shore at the harbor of Moline and pool of the Moline Water Power Company the conditions are such as to prohibit the extension of the canal along the water-front of Moline, and it becomes necessary, therefore, to make two independent canals, connected by a section of the river, in order to continue navigation to the foot of the rapids.

The most direct and feasible route for this part of the improvement would be down the outside of Rock and Benham islands. It would be about 3 miles long and have a width of from 200 to 300 feet, with one and possibly two locks, the river channel connecting the two canals being deepened to 6 feet at low water. This connecting channel would open into the main channel of the river and permit either canal to be used independently of the other, and afford easy entrance to the harbor of Moline.

The total cost of the whole of this improvement from the head to the foot of the rapids is placed by the Board at about $4,000,000.

But it being thought practicable, at a moderate cost, to obviate many of the difficulties existing in the navigation of the rapids, especially to render them navigable at night, the Board presents for this purpose a plan recommended by the engineer officer in local charge at this place, in which the desired improvement is to be attained by guide-piers, with lights and day-beacons attached, in sufficient number and so located as to serve as guides to pilots at night; and in addition, to excavate and remove the rock at various points so as to widen and straighten the channel at the crooked parts of the rapids, to give longer straight reaches; also to deepen the channel where necessary; to build dams where required to equalize the slope, and to remove by dredging the present accumulations of sand and gravel which interfere with navigation.

It is estimated that the probable cost of such work would be $330,000.

The Board, after careful examination of these two methods of improvement, is adverse to the construction of a lateral canal at this time, as it is not regarded as indispensable to meet the present wants of navigation, and is of opinion that the existing navigable channel of Rock Island Rapids should be improved to such an extent as to make the passage over them as reasonably safe by night or day as the natural conditions permit, the depth to be limited to 4 feet at low water.

The above plan, which is recommended by the Board to accomplish this, will furnish the relief immediately called for in the interests of navigation, and would also form part of any more extended project for widening and deepening the channel if adopted in future; but when the improvement of the Mississippi River now in progress furnishes a depth of 6 feet at low water at all points below Rock Island Rapids, in the opinion of the Board, the construction of canals, as above described, will provide, at less cost and in a more desirable manner than a further improvement of the rapids, the additional 2 feet of depth that may then be required for navigation.

I fully concur in the views and conclusions of the Board.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

REPORT OF A BOARD OF ENGINEERS FOR THE FURTHER IMPROVEMENT OF NAVIGATION AT THE ROCK ISLAND RAPIDS OF THE MISSISSIPPI RIVER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill, January 16, 1889.

GENERAL: The Board of Engineer Officers constituted by Special Orders, No. 59, Headquarters Corps of Engineers, U. S. Army, October 29, 1888, "to prepare and submit a project for the improvement of navigation at Rock Island Rapids, Mississippi River, either by widening and deepening the present channel through the rapids or by a canal around the rapids on the Illinois side of said river," met at Rock Island, Ill., on November 21 and 22, 1888. At this session the maps and records of the United States engineer office at Rock Island were examined, a personal inspection of the rapids was made in company with skillful pilots and navigators, interviews were had with a number of parties interested in the navigation of Mississippi River, and a hearing was given to the representatives of the Business Men's Association of Moline. The Board adjourned on November 22, 1888, to give time for the completion of the surveys of certain portions of the rapids, the plotting of notes, and the preparation of the estimates called for by the act of Congress. A subsequent meeting was held at Rock Island, Ill., on January 15, 1889.

Having considered all the available facts bearing upon the questions presented, the Board has the honor to present the following report:

The instructions of the Board are found in the act of Congress approved August 11, 1888, as follows:

And inasmuch as the present channel of the Mississippi River at the Rock Island Rapids is said to be of insufficient width and depth, and dangerous to the navigation of said river, the Secretary of War is hereby authorized and directed to cause an ex-

amination and survey to be made at said rapids, with the view of determining the best and most economical mode of securing a safer channel of greater width and depth, sufficient to meet the necessities of the commerce and navigation of the river, either by the construction of a canal around said rapids on the Illinois side of said river, from the head of the rapids near Rapids City, Ill., on the most direct and feasible route to the main river, at the foot of said rapids, or by widening and deepening the present channel of the river at said rapids. And the Secretary of War shall cause a report of said examination and survey to be made to Congress at its next session, together with plans and estimates of the probable cost for the construction of such canal, or for the widening and deepening of the present navigable channel of the river; and, with such plans and estimates, shall submit his opinion as to the best and most economical plan of improving the river at said rapids in the interest of the commerce and navigation of the river. And for the purpose of such examination and survey, so much of the above appropriation of six hundred thousand dollars as may be necessary is hereby authorized to be expended, not to exceed fifteen thousand dollars.

The improvement of the Rock Island Rapids was commenced by the Government in the year 1867, under plans which, at that time, appeared to be sufficient for purposes of navigation and justified by the interests of commerce involved and the general condition of Upper Mississippi River, and the work was virtually completed in 1882, at a cost of $1,166,608.50. A final report on this improvement, including a history of the work, appears in the Report of the Chief of Engineers for 1886, pages 1427–1465.

The natural condition of the rapids, and the reasons leading to the adoption of the plan of improving the open channel by the making of cuts through the obstructive chains, giving a channel 200 feet wide with depth of 4 feet at low water, are given in the following extracts from a report made in 1866 by Capt. (now Lieut. Col.) P. C. Hains, Corps of Engineers, United States Army:

The Upper Rock Island Rapids begin at a point near the lower end of Rock Island, and extend 14.26 miles up the river to a point near the lower end of the town of Le Claire. The bed of the river throughout this entire distance consists of a hard surface of limestone rock, worn in many places into deep furrows by the long-continued action of the water and the material washed along the bottom. This rock crops out along the shores, and is generally found stratified in thin layers. The lower strata in the bed of the river appear to be harder, and of different thickness—from 4 inches to 2 feet and upward. There are also a number of large erratic bowlders of granite to be met with, but these, as a general thing, do not present serious obstructions, but in some cases, as at Campbell's Chain, they rather serve as guide-marks for pilots, who would protest against their removal on that account, unless replaced by other equally permanent marks.

The only difficulty in the way of navigating the rapids consists in passing over the chains, of which there are seven, viz: The Upper or Smith's Chain, Sycamore, St. Louis, Campbell's, Duck Creek, Moline, and Lower chains. At these places the rocky bed of the river projects out from each shore like a bar, the projecting points sometimes overlapping each other, leaving only a narrow, tortuous channel between them, and in some instances extending like a dam or rocky bar entirely across the river. Between the chains, throughout almost the entire distance, is a wide and navigable channel, with plenty of water for boats that navigate the Upper Mississippi, and at such places the velocity of the current is much less than on the chains.

Between the head and foot of the rapids, a distance of a little more than 14 miles, nearly 11 miles are good navigation in the lowest stages, the obstructed portion covering a distance of only a little more than 3 miles.

* * * * * * *

The average length of the boating season is about 260 days. During the winter, as a matter of course, navigation is closed by the ice.

When the river is open to navigation about one-third of the whole time is rendered dangerous by the shoalness of the water on the rapids, and sometimes impassable for boats drawing more than 2 feet. In the year 1864 the water was lower than had been known before in many years, attaining its lowest point September 2.

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The average width of the river on the rapids is about one-half mile. At Le Claire it is only 1,500 feet in one place, but widens out above and below. Below the rap-

ids the river is wider than on them, as may be seen from the map. A line of levels, from the head to the foot of the rapids, shows a fall of 21.46 feet in a distance of about 14 miles, or an average fall of 1.53 feet per mile in low water.

The greatest fall is on Moline and Sycamore chains.

The area of a cross-section at the head of the rapids, where the river is only 1,650 feet wide, is 30,220 square feet; at a point near Sycamore Chain, 12,408 square feet; at Moline Chain, 6,829 square feet.

* * * * * * *

Although there is no evidence of any specific plan having been proposed for the improvement of these rapids, except that of improving the natural channel itself by excavation, so as to give 4 feet depth in low water and a passage way 200 feet in width, several plans have been proposed in a general way for overcoming the difficulties.

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As I have already remarked, I think that the time has not yet come when a canal is necessary in order to overcome the difficulties of navigation on the rapids, nor is it difficult to see that even a canal improvement would fail to confer all the benefit on commerce that a perfect improvement of the river itself would.

I have conversed with a number of persons interested in the navigation of the Upper Mississippi, and they all admit that 4 feet of water on the rapids is all that is required; in fact, in low stages, boats can not carry more than from 3 to 4 feet above and below, and hence more than 4 feet on the rapids is unnecessary. As this depth can be had more economically and quickly by the plan of improving the channel than in any other way, and moreover, as it gives all the facilities that the present commerce demands, I am of the opinion that this is the plan that should be adopted.

If, however, at any future time the navigation of the river should be improved so as to produce more than 4 feet above and below the rapids in low water, and consequently to require more than 4 feet on the rapids, I would recommend the adoption of some other plan, as the amount of excavation in that case (supposing the river was improved so as to secure 6 feet) would probably be so great as to render its cost far more than the construction of a canal.

But let me add that, whatever may be the ultimate demands of commerce or the ultimate plan that may be adopted to satisfy those demands, this improvement will in no wise be thrown away. It will always be useful and should, in my opinion, be made, even though a canal were to be built to-morrow.

There are many boats navigating the Upper Mississippi that never require more than 4 feet, and for such this improvement will at all times be ample; besides it is probable that when more than 4 feet has been obtained in low water on the bars above and below the rapids the commerce of this river will be beyond the capacity of any one canal to accommodate.

There are many advantages connected with the channel improvement that do not exist in connection with other plans, and these must all have weight in deciding this question.

It will be free. It will not require an annual appropriation from the General Government to keep it in repair, and when completed will be permanent.

It will not interfere with a canal improvement in case that it should at some future time become advisable or necessary; and, moreover, the benefits arising from this plan will be felt as the work progresses. Every patch of rock removed is that much benefit to navigation, whereas a canal improvement can be of no benefit until completed.

The latter, however, has one advantage, viz, in affording safe navigation in the darkest and stormiest nights.

The principal objection urged against the application of the channel improvement at these rapids is without substantial foundation.

It is feared that by deepening the channel to 4 feet in low water and widening it to 200 feet will increase the capacity of the water-way to such an extent as to draw off from the pools above such an amount of water as to develop new dangers where these heretofore did not exist. But by a careful examination one can scarcely fail to see that this objection is groundless.

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Believing that the plan of improving the natural channel of the river is the one that should, at the present time, be carried out at these rapids, and also that the practicability of getting 4 feet water in the lowest stages for a channel 200 feet in width is beyond question, I desired to have my views strengthened if they were correct, or their fallacy demonstrated if not; for this purpose I requested that a board be convened consisting of civil engineers in the Government service for the purpose of considering some of the proposed plans of improvement.

* * * * * * *

The report of the Board referred to is as follows:

The Board met in pursuance to the above order, and having carefully investigated the advantages and disadvantages of the various plans proposed for the improvement of the Rock Island Rapids, recommend the following:

(1) That the present steam-boat channel be enlarged, by excavation, to a minimum width of 200 feet and a navigable depth of 4 feet, at the time of low water, which is somewhat greater than the ruling depth in the river north and south of the rapids during that season.

This recommendation is made in view of the economical execution of the work and the present demands of commerce.

Should the ultimate interests of commerce demand a greater depth than 4 feet, as it would in case a greater depth could be obtained above and below these rapids, the plan of an independent canal and locks without dams would then best promote that interest, the practicable result of such a plan being beyond question.

(2) That the excavated material be so deposited in the river-bed as to check cross-currents and confine the volume of water as far as practicable to the new channel.

(3) That coffer-dams be used in carrying on the work, more particularly, however, at Moline and Campbell's chains.

From the best information we can obtain they can be put in by the 1st of September, the period of low water beginning about this time, leaving at least three and a half months for taking out the material; but, as the work is to be done by contract, the mode of operations may be left, to a great extent, to the contractor.

(4) That the work should not be entered upon until an appropriation be made which will cover its estimated cost, experience having shown that small consecutive appropriations in such cases augment the ultimate expense beyond all reasonable calculation and are virtually thrown away in mere preparation.

(5) That the improvement which has been proposed by means of locks and dams across the river is inadmissible. It would erect an obstruction permanent throughout the year, whereas at high and ordinary stages no hindrance to navigation now exists.

* * * * * * *

It appears that, in navigating the rapids before improvement, boats were obliged, except at times of high water, to follow a narrow and crooked channel, dangerous at all times, impossible during times of wind, and only available during low water for the lightest draught boats and barges; rafts were taken over in small pieces; accidents were frequent; and, in general, the delays, risks, and expense of passing the rapids were so great that such passage was only made practicable by the flourishing condition of river commerce and the profitable freight rates.

The original improvement of the Rock Island Rapids, which was made when obstructions in the Upper Mississippi River were numerous, brought the channel over the rapids to a condition comparing favorably with other portions of the river. Considering the results sought, the work carried out was a success, furnishing for steam-boats a practicable and comparatively safe daylight channel, with a low-water depth as great as at many portions of the river above and below, and permitting rafts to be taken over at the lowest stages in two pieces, instead of eight or ten, as formerly. But the radical improvement of the low-water channel of the Upper Mississippi River, inaugurated in 1878, has already removed many of the old-time obstructions, bringing those at the rapids into greater prominence, and experience has shown that there still exist several causes of difficulty, danger, and delay in connection with the passage of the rapids, which, in the present day of light freights and low rates, materially affect the interests of river transportation. The remaining obstructions may be classified as follows:

(1) Patches of rock in the channel, some of which were discovered after the completion of the improvement and others of which were not fully removed.

(2) Excavation not down to grade, as at Duck Creek Chain, where the depth is now found to be some inches less than 4 feet at low water.

(3) Cross-currents, caused by secondary channels, which give considerable trouble at low stages.

(4) Excess of current for short reaches, as at Lower, Moline, Sycamore, and Upper Chains.

(5) Sand-bars which, owing to lack of current, have accumulated at the head and foot of Campbell's Chain and above the head of Winnebago Island.

(6) Insufficient width at bends in the channel. While the width of 200 feet is not so objectionable in straight reaches, it is found to be insufficient for easy navigation in the crooked portions of the channel.

(7) Insufficient depth. The grade of excavation through the chains was originally fixed at 4 feet below extreme low water, which gives a depth somewhat greater than the ruling depths above and below the rapids, and permits all boats which can successfully navigate other parts of the river to cross the rapids. But large boats, ascending the rapids at low stages, draw down with their wheels the water in the cuts, and so materially reduce the depth of water under their hulls as to interfere with headway and management.

(8) Unfavorable winds. The rapids, except at high or medium stages, are navigated with difficulty during unfavorable winds; but this same trouble is experienced in the passage of all bridges over the Upper Mississipi, in the Des Moines Rapids Canal, and, at times, even in the sandy portions of the open river.

(9) Delays at night. With a stage of less than 8 feet above low water, packets drawing 4 feet and over can not, as a rule, cross the rapids at night, and, at a stage of less than 6 feet, the same is true with regard to boats drawing 3 feet. Delays from this source, at least for packets, are more vexatious and expensive than from all others combined. Owing to the crookedness of the channel and the swift current on the chains, it has not been found practicable, in the present condition of the rapids, to provide such a system of lights as will permit the safe management of boats at night.

From the facts presented it appears that, while "the present channel of the Mississippi River at the Rock Island Rapids" is a practicable one under favorable conditions of light and wind, it is not entirely safe during the greater portion of the year and can not be used at night, excepting at high stages of the river. The channel is "of insufficient width and depth" at certain places, and, under certain conditions, "dangerous to the navigation of the river."

In accordance with instructions the Board has considered and prepared estimates for two methods of further improvement, "a canal around said rapids on the Illinois side of said river," and "widening and deepening the present channel of the river at said rapids." The question of a canal on the Iowa side of Mississippi River, not coming within the instructions of the Board, has not been considered.

LATERAL CANAL AROUND THE ROCK ISLAND RAPIDS ON THE ILLINOIS SIDE OF MISSISSIPPI RIVER.

The head of the Rock Island Rapids on the Illinois side of the river is at Rapids City, and the foot of the rapids is a short distance above the Rock Island railroad bridge, the total length by Illinois shore being about 13.5 miles. About 11 miles below Rapids City, opposite the head of the island of Rock Island, is the city of Moline. Between the island and the Illinois shore is what is termed the harbor of Moline and the pool of the Moline water-power. The conditions are such as to prohibit

the carrying of a canal along the water-front of Moline, or through the cities of Moline and Rock Island, to the main river below the rapids. Two independent canals, connected by an improved section of the river in front of Moline, are therefore necessary.

(1) "The most direct and feasible route" for a canal from Rapids City to the upper portion of Moline is in the bed of Mississippi River, along the Illinois shore. General plan and estimates for such a canal have been prepared. The location is shown on the accompanying tracing. The proposed canal is 10.39 miles in length and formed, as in the case of Des Moines Rapids Canal, by the construction of an earthen embankment, well protected by riprapping and paving, in the river, giving a width to the canal throughout the greater portion of its length of from 200 to 500 feet, and a depth at low water increasing from 6 feet at the head to about 12 feet at the foot. Two locks are provided: one at the head with lift varying from zero at low stages to 9.6 feet at extreme high water, and one at the foot with lift of about 12.1 feet at low water and zero at stages greater than 12.1 feet above low water. These locks are 80 feet in width, with available length of 325 feet. The water-surface of such a canal could be kept at or near that of low water at Rapids City, and but a very small amount of embankment would be required on the shore side at the lower end. The river embankment, which would rise 2 feet above extreme high water, would serve to protect a large portion of the Illinois shore adjacent to the canal from overflows, to which it is now subjected, and would also assist materially in the improvement of an open-river navigation by straightening and regulating the channel and currents. The width and depth of such a canal are sufficiently great to permit the comparatively rapid movement of boats. The estimated cost of the proposed canal, $2,267,507.55, is based on prices for rock and earth-work and masonry, which are thought to be ample, provided the work were carried on under liberal appropriations.

The plans and estimates for a surface canal from Rapids City to Moline, as prepared under the direction and at the expense of the Business Men's Association of Moline, have been considered by the Board. Such a canal requires, as compared with the canal in the bed of the river, more masonry, one more lock, and more lockage; gives less width and depth, and less convenient approaches; and is complicated with a feeder from Rock River 12 miles in length. The only advantage claimed for such a canal is, that its estimated cost, $2,280,400, is less than that of a canal in the bed of the river; but, as is shown by figures given, this claim is an error. But, regardless of cost, it appears to the Board that a canal in the bed of the river, as recommended, is the only one that would fully serve the interests of navigation.

(2) "The most direct and feasible route" from the Moline Pool to the main river below the rapids is down the outside of Rock and Benham's islands. This canal would be about 2.9 miles in length, and through the greater portion of its length from 200 to 300 feet in width, with depth varying at low water from 6 feet at the head to about 10 feet at the foot. The total fall in this distance is about 5.9 feet at high water and 7.7 feet at low water, and but one lock will be necessary if the high-water level at the head of Moline Chain can be carried down to the foot of the canal without detriment to the island of Rock Island. Otherwise two locks must be provided, but only one would be necessarily in use at any stage. The estimated cost of this canal with one lock is $1,111,934.12, and with two locks $1,298,321.42. The location for upper portion of canal and lock on the outside of Benham's Island possesses many advantages, and, by reducing the section of the river,

would undoubtedly improve the channel on Moline Chain at low stages; but possibly further surveys and observations may show that the reduction of section would be objectionable at high water, and, if such a conclusion be reached, it would be advisable to locate the upper part of canal between Rock and Benham's islands. Such a change in location will somewhat increase amount of the rock excavation and the cost of the canal, if it be found necessary to continue up on the Moline side of the dike above Benham's Island. It is also possible that after further surveys it may appear desirable to locate the lock at the foot of this canal a little further up the river.

When the commerce of the Upper Mississippi may demand and justify the construction of canal navigation around the Rock Island Rapids, the necessity of this lower canal will be first felt, and its construction may be undertaken some time in advance of the upper canal. Were this not the case, it would be admissible to consider a plan for materially reducing the rock-cutting in the lower canal by a permanent raising of its water-surface through sufficient pipe connection with the upper canal. This plan would necessitate at all stages of less than about 6 feet the locking-up into the canal from the river at both ends.

In the pamphlet published by the Moline Business Men's Association a route for a canal below Moline is generally described, but no detailed plans for such work are presented. The route is down through the pool of the Moline water-power, behind the island of Rock Island. The approximate cost given is $724,475.50, which amount must be increased by several hundred thousand dollars for the rock excavation necessary for giving a navigable channel from the head of the island of Rock Island to a point below the Moline Bridge. This route, through the water-power pool and through three draw-bridges, with an outlet in the eddy water at the foot of the island of Rock Island, is a very objectionable one.

(3) A channel, with depth of 6 feet at low water from the lower lock of the upper canal to the head of the Benham's Island Dike, is necessary for connecting the two canals. To excavate such channel will require the removal of 59,142 cubic yards of rock, at a probable cost of $325,281. This connecting channel also opens into the main channel of the river at the head of Moline Chain, thus permitting either canal to be used independently of the other and affording easy entrance to the harbor of Moline.

WIDENING AND DEEPENING THE PRESENT NAVIGABLE CHANNEL OF THE RIVER.

The length of the Rock Island Rapids on the line of the low-water channel from the buoy above Upper Chain to the Rock Island Railroad Bridge is 14.7 miles. The total fall in this distance, at a 2-foot stage, is 19.9 feet. At other stages the fall varies slightly. The fall is not uniform, being concentrated at some of the chains, the slopes and currents on other chains and in the pools being comparatively small. The greatest fall is at Upper, Sycamore, Moline, and Lower chains. In the pool at Hampton and in Campbell's Chain the current is not sufficiently swift to prevent an obstructive accumulation of sand.

From the head of the rapids to Moline Chain, which chain marks a radical change in the general slope of the rapids a distance of 11.4 miles, the fall is 12.1 feet, the steepest slope being at Sycamore Chain.

From the head of Moline Chain to the Rock Island Bridge, a distance of 3.44 miles, the fall is 7.78 feet, the fall in a portion of the distance

exceeding 4.66 feet to the mile, producing a current, at times, which it is difficult for boats with little power or with tows to stem.

If the fall from the head to the foot of the rapids were distributed uniformly, we would have a slope of about 1.5 feet to the mile, but the great cost of accomplishing this result and some uncertainty as to results render such plan impracticable.

If the fall from the head of the rapids to Moline Chain were distributed uniformly, we would have a slope of about 1 foot to the mile. To accomplish this would require some rock-cutting to give a depth of 6 feet and a large amount of work for equalizing sections and raising water surface, etc.; so much work in fact that even this plan, while results could be assured, does not appear perfectly practicable. But, in this stretch, the formation of a channel by widening and deepening the cuts through the chains and a limited amount of work for equalizing sections would be attended with no engineering difficulties, and a proper execution of the work would result not only in a deeper and more direct channel, but also in a reduction of the slope and current where desirable; but the cost of the rock excavation and other work required would be, as shown hereafter, very large.

In connection with the question of the practicability of a further improvement of the channel from the head of the rapids to Moline Chain, it may be stated that the fall in the improved channel from Montrose, Iowa, to the Guard Lock of Des Moines Rapids Canal, over the upper portion of Des Moines Rapids, a distance of 3.2 miles, is about 4 feet, on a portion of the distance the slope being over 2 feet to the mile and giving a velocity of about 2.8 miles per hour. Boats and rafts can navigate this stretch of river with comparative ease both day and night, the channel being well marked and lighted and the current no serious obstruction.

The section from the head of Moline Chain to the Rock Island Bridge is susceptible of some improvement by building up the water-surface between Moline and Lower chains and reducing the steepest slopes; but considering the amount of improvement to be secured thereby, the work does not seem justifiable, and to secure a depth of 6 feet would necessitate much rock excavation at Moline and Lower chains and such additional work at the head of Moline Chain as would prevent the lowering of the pool above.

From such gauging observations as have been taken at low stages it is estimated that the low-water discharge on the rapids is about 19,000 cubic feet per second. Measurements taken at St. Louis Chain in 1880, at a stage 1.35 feet below high water, gave a discharge of 211,240 cubic feet per second; and observations just below the rapids, at a stage of 18.4 above low water, within a few tenths of a foot of extreme high water, gave a discharge of 251,348 cubic feet per second.

In the Report of the Chief of Engineers for 1880, pages 1537–1539, is found a special report upon the subject of widening and deepening the channel of the Rock Island Rapids, submitted under date of March 15, 1880, in response to a resolution of the House of Representatives. In this report are given the following estimates, prepared under the direction of Maj. F. U. Farquhar, Corps of Engineers, by E. F. Hoffman, the assistant engineer under whose immediate supervision the improvement of the rapids was carried out. These estimates, so far as the chains are concerned, were based on very detailed surveys, but the maps from which the cost of necessary work in the pools was calculated are not so complete, and it may be possible that in carrying out the proposed widening and deepening the necessity would be developed for more

work in the pools than is covered by the estimates; but the estimates given are as close approximations as can be made by this Board with the information which it is practicable to secure at this time of the year and in the limited time permitted by the necessity of reporting to Congress at present session. These estimates were based on a cost for removal of rock of $6 per cubic yard, and the plans contemplate such widening and straightening of channel as will give easy changes of direction and comparatively long straight reaches, permitting the establishment of lights and the navigation of the rapids at night. The additional work of establishing piers, and any dams considered necessary for reducing velocity of current at swift places by regulating the slope and section, would very materially increase the estimates given below.

To increase the width of channel to 400 feet, giving a depth of 4½ feet below low water, which will insure a grade as low as that of the present cut, will require the removal of 209,811 cubic yards of rock, and will cost approximately $1,258,866.

Boats drawing 5 feet can pass through the Des Moines Rapids Canal during extreme low water.

If it is deemed advisable to give the same available depth and a perfectly safe channel over the Rock Island Rapids, the cuts should be made 400 feet wide and excavated to a depth of at least 6 feet below low water of 1864. This would require the removal of 581,835 cubic yards of rock, which would cost approximately $3,491,010.

The further improvement of the Rock Island Rapids has been considered from time to time, by the engineer officer in local charge, as a part of the improvement of the Upper Mississippi River, and a project for some additional work on the rapids has been prepared. From such project the following extracts are taken:

It being thought practicable at a moderate cost to obviate many of the difficulties with which the navigation of the rapids is beset, and especially to render the rapids navigable at night, consultation was had with many navigators, including all of the more experienced rapids pilots, and frequent trips mere made by steam-boat over the rapids for the purpose of studying the problem closely at a low stage of water, and the resulting plan and project, which meets in nearly all of its details with the approval of navigators, will, it is thought, materially lessen the present obstructions to navigation.

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It is believed that all the work included in the plan given below is fully warranted by the present needs of commerce, and also that, when, at some future day, the commerce of the river shall require greater depth of channel and justify an additional expenditure of money for canal or further improvement of the open channel, the plan will, with slight exception, be found to be in harmony with and in the direction of such more complete improvement. It will be noted that each detail of the plan accomplished will be in itself of immediate benefit, and that the cost of the various items is not so great but that some of them may very possibly be provided for annually by allotments from general appropriations in case no special appropriation be made available.

The proposed improvement is to be accomplished in the following manner:

(1) Guide-piers, with lights and day beacons attached, are to be built [design shown on map] of sufficient strength to resist the action of ice, and in sufficient number and so located that, while being of no obstruction to navigation, they will serve as reliable guides to pilots in making the passage at night. It may possibly be necessary to supplement this arrangement with a few range-lights and some buoys in addition to those now in use

(2) It is proposed to excavate and remove rock at various points in order to widen and straighten the channel at crooked portions of the rapids, giving longer straight reaches, and to deepen it at some places, as at Duck Creek Chain. Such excavation will include the several small patches of rock lying in and near the channel.

(3) A system of dams is proposed for slightly raising the water-surface at low stages and equalizing to a certain extent the slopes above and below Hampton, especially increasing the current through Campbell's Chain, with a view to preventing the deposit of sand in the channel. A large amount of dredging is also proposed to furnish gravel for dam construction and to remove the present accumulation of sand, which interferes with navigation. It will probably not be necessary to construct all the dams indicated, and a change of location may be shown to be desirable by experience.

The proposed locations for guide piers and for rock excavation are given in the following detailed project (see map):

At Upper Chain.—Pier No. 1 is located on the left hand upper corner of the cut, about where Buoy No. 2 is. Rafts and boats keep well to the right or Iowa side, and this pier would be out of the way. This pier may be set back 50 to 100 feet from the edge of the cut. A short distance below the cut, on a projecting point of rocks, where Buoy No. 3 now is, Pier No. 2 is located.

At Smith's Chain.—It is proposed to remove the ledges of rock lying between the old and the new channels, widening the channel where the passage is now difficult to about 400 feet, and requiring the excavation of about 1,800 solid cubic yards of rock. These ledges of rock are surrounded by tolerably deep water, and probably but a small portion of the material broken by blasting or by chisel will have to be dredged up. What is removed can be used in checking the cross-currents at French Channel and head of Raft Channel. The United States light on the large rock pile at Smith's Chain must be kept up, as also Buoy No. 4 on the small rock pile.

From Smith's Chain to Sycamore Chain.—On the left, Pier No. 3 is located on a point of rocks above Sucker Chute, and Pier No. 4 is located on a point of rocks below Sucker Chute, where Buoy No. 8 now is. These will be out of the way of navigation and form excellent guide-marks. On the right or Iowa side, at the rock pile where Buoy No. 6 is, locate Pier No. 5.

At Sycamore Chain.—This is one of the worst points on the rapids, arising from current and crooked channel. On the edge of the Sycamore Cut, Iowa side, about 800 feet below Pier No. 5, place Pier No. 6. The channel at Sycamore is to be widened by excavating about 4,000 solid cubic yards from the Illinois side. This material can be used in filling or damming the side drafts at Sucker Chute, Sycamore, and Iowa Channel. The United States light on the Illinois side at Sycamore should be maintained.

At Crab Island Chain.—Pier No. 7 is located at Envoy Rock, where Buoy No. 9½ now is. Pier No. 8 is located at foot of Crab Island. To widen the channel at Crab Island and make it easy to run an excavation of about 600 solid cubic yards of rock will have to be made from the Crab Island side.

At St. Louis Chain.—Pier No. 9 is located at or near St. Louis Rock. There are several small patches and points of rock to be removed at this chain, requiring an excavation of about 500 solid cubic yards.

At Cabin Chain.—Pier No. 10 is located on the Illinois side of channel near Buoy No. 11. There remain to be excavated at this chain several patches and points of rock, aggregating 500 solid cubic yards. Pier No. 11 will be placed on the point of rocks where Buoy No. 12½ is, at the head of Hampton Reach.

At Campbell's Chain.—A large amount of work will be needed here, including three piers: Pier No. 12, on the Illinois side of channel about 400 feet above head of cut; Pier No. 13, half-way from head to foot of cut on Illinois side; and Pier No. 14, at lower end of chain, near Buoy No. 16. A patch of rock in the channel, opposite Buoy No. 16, and containing about 200 solid cubic yards, is to be excavated. The cut at Campbell's must be widened and straightened by removing about 5,300 solid cubic yards of rock from the Iowa side. The current at Campbell's Chain being sluggish, a large amount of sand has collected at its upper and lower ends, which often causes great trouble to navigation. To remove this obstruction and keep the channel clear, a system of five wing and three closing dams is proposed; but it is not thought probable that it will be necessary to construct more than two or three of the wing-dams. The closing dam No. 8, connecting Campbell's Island with the main shore, is very important, but closing dams Nos. 1 and 7 may not be found necessary. The object of the dams is to increase the current at Campbell's Chain and thus keep the cuts clear from sand, and also to somewhat change the slope of the river from St. Louis Chain to Winnebago Chain, with a view to gaining a few more inches of water at St. Louis and Cabin chains. The dams will probably have to be constructed of rock, with perhaps some gravel, and paved on top to prevent washing of fragments of stone into the channel-cuts.

At Winnebago Chain.—It seems to be conceded by all that this chain needs some widening at its head and also at its lower end. An excavation of about 800 solid cubic yards is proposed at the head near Buoy No. 17, where a reef of rocks projects, making an awkward turn at a narrow place in the channel; and at the lower end of the chain an excavation of about 1,600 solid cubic yards is called for. This will widen the channel through the entire chain to about 300 feet. Pier No. 15 is located at the Winnebago Bowlder. A permanent light on lower end of sand-bar at foot of island may also be called for.

From Winnebago Chain to Duck Creek Chain.—There is a tolerably wide and deep channel in this stretch which will, it is thought, be made perfectly safe with a few piers and by the removal of a patch of rocks above Duck Creek. Pier No. 16 is located at a point of rocks on Illinois side, about 2,000 feet below Winnebago Island, near Buoy No. 17½. Pier No. 17 is located on the projecting point of rocks about 300

feet below Mason's Rock, where Buoy No. 19 is. Pier No. 18 on the point of rocks, Iowa side, about 600 feet above head of Duck Creek Cut, where Buoy No. 20 is. It may be well to set this pier from 50 to 100 feet back from the channel. Opposite Buoy No. 20, on Illinois side of channel, but covering to some extent the entrance to the Duck Creek Cut, are some bad patches of rock, aggregating 200 solid cubic yards, which should be removed.

Duck Creek Chain.—For this chain two piers are recommended—Pier No. 19 at the upper corner of the cut, Iowa side, and Pier No. 20 at the foot of the chain, Iowa side, opposite Buoy No. 22. The cut at Duck Creek Chain is too narrow and shallow. To widen it to 300 feet by a 100-foot cut from the Illinois side would require an excavation of about 6,850 solid cubic yards. This work, though expensive, is recommended. It is further proposed to deepen the present cut by the excavation of about 2,000 solid cubic yards. The amount of excavation, as estimated from recent accurate maps, is much larger than this; but a great part of the rock is but a few inches above grade, distributed over a very large area, and it is thought that the excavation of 2,000 cubic yards, taken in connection with the proposed widening of the cut, will give sufficiently satisfactory results.

At Cottonwood Chain.—The channel here makes a bend and is close to shore. It is proposed to widen it to about 300 feet by the excavation of about 1,660 solid cubic yards of rock. A permanent light is needed on the Iowa shore at Cottonwood Chain.

Between Cottonwood Chain and Moline Chain.—At Buoy No. 23 the channel makes an awkward turn and is quite narrow. It is proposed to widen and straighten the channel by removing some points of rocks, aggregating about 1,220 solid cubic yards, from both sides. Pier No. 21 is located at this point, on the Illinois side of the channel.

Moline Chain.—For this chain two piers and a light on the causeway are recommended. Pier No. 22 is located on the Illinois side of the cut, about half-way down, and Pier No. 23 at the foot of dike near lower end of Benham's Island. A large number of dangerous patches of rock in the channel at this chain must be removed, aggregating in amount of excavation 1,800 solid cubic yards.

From Moline Chain to Lower Chain.—The channel is straight, deep, and wide in this stretch and a light on the Davenport shore at Stubb's Eddy, or perhaps a range light, is all that is needed.

Lower Chain.—At the head of this chain the point of rocks on the Illinois side is very dangerous, probably the worst place for rafts on the rapids. Buoy No. 25, at this point, is being continually carried away. The excavation formerly done by the United States at this locality was insufficient. It is proposed to further remove rock to a channel width of 400 feet, and also to widen the channel at the turn below by excavation from both sides of the channel. Amount of excavation required, 3,710 solid cubic yards. It is thought that with the improvements suggested this chain can be run at night by range lights; but it is also proposed to locate Pier No. 24 on Iowa side of channel just below the turn.

It is proposed to keep up the present system of buoys (where not replaced by piers), and even to enlarge it, so as to afford every facility possible for the guidance of pilots.

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The work as above described is based on the best information now available. During the progress of such work new information would be secured. It is proposed, of course, to take advantage of such information, and where further experience suggests minor changes of detail, such changes would be made.

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RÉSUMÉ OF ESTIMATES.

Rock excavation, 33,140 solid cubic yards, at $6 per cubic yard	$198,840
Dam construction, 39,500 cubic yards, at $1.50 per cubic yard	59,250
Piers, 24, at $1,500 each	36,000
Dredging of sand	5,000
Contingencies	39,909
Total	328,999

The estimated cost of the work proposed, which it is thought will provide for reasonably safe navigation day and night, and furnish probably all the relief to interests of navigation immediately necessary, and which is a part of the general scheme for a more extended system of widening and deepening the channel over the rapids, is of course only approximate; but in making it the prices taken are large, and some work is included which circumstances might show to be unnecessary, and each item is considered separately, whereas the work could probably be so combined by the use of excavated rock and dredged material in the dams and piers as to materially reduce the total cost.

OPINIONS OF EXPERIENCED NAVIGATORS AND VESSEL-OWNERS.

In order to secure the testimony of those whose actual experience makes their opinions of value in connection with a consideration of the questions before the Board, a circular letter was addressed to all known available parties owning, operating, or managing packets and raft-boats on the Upper Mississippi River. This letter recited the clause in the river and harbor act of August 11, 1888, in accordance with which this investigation is being made, called for opinions as to the present condition of the channel over the Rock Island Rapids, and requested, in case additional facilities were thought to be required, views as to the best method of furnishing relief. Of the seventy-five parties addressed about forty have responded, and the opinions of many others have become known to the Board. All consider the present channel over the rapids insufficient in width and at some points in depth, and somewhat dangerous to navigation, and that the interests of commerce involved justify such improvements as will make the passage of the section of the river obstructed by the rapids as safe, easy, and rapid as the natural conditions permit. Seven replies favor the construction of a canal around the rapids, the opinions being based on the belief that a safe and easy channel can not be secured at reasonable cost, if at all, by an improvement of the natural channel. All others consider a canal unnecessary and undesirable, being of opinion, based on the results already accomplished, that the open channel is susceptible of all needed improvement and that such open channel is very much to be preferred to any canal navigation. With only one exception, all parties interested in raft navigation whose opinions have been made known to this Board, basing such opinions on experience at the Des Moines Rapids Canal, assert that, so far as raft navigation is concerned, any canal would cause greater delays and be more difficult to navigate than the rapids, even in their present condition, and that rafts would not use such canal under any circumstances.

BUSINESS AFFECTED BY THE OBSTRUCTIONS AT THE ROCK ISLAND RAPIDS.

The money value to the interests of commerce of safe and easy navigation of the Upper Mississippi River, including the Rock Island Rapids, must be measured by the saving to the general public in freight rates, which results not only from the actual transportation of freight by water, but also from the effect of a favorable water route on the rates of competing lines of railroad. This effect, which, as a result of improvements already carried out, is now very large, can be made much greater by such additional work as will permit a further reduction in the cost of water transportation. The actual amount of business which is now or will be in the future affected by the practicability of transporting freight at low rates on the Upper Mississippi can not be stated, but the amount is known to be very great.

The principal classes of navigation to be considered in connection with the further improvement of the Rock Island Rapids are the large through packets carrying freight between St. Paul and St. Louis and intermediate points, and the raft-boats with their tows of logs and lumber. The latter class is at present by far the most extensive, the proportion of raft-boats to packets being about ten to one. The packets, though, are much larger than the raft-boats, some being 300 feet in length, and the rapids are to them a greater obstruction on account of their size. During the year 1887 there passed over the rapids 2,660 steam-boats of

all classes, 271 barges, and 774 rafts, each containing on an average probably 1,000,000 feet, B. M., of lumber. The records of the past ten years indicate that these figures give a fair representation of the present business over the rapids. Those best informed are of opinion that the rafting business, for logs at least, will continue for many years, and that the passenger and freight business of the packets will materially increase as the country tributary to the river becomes more thickly settled, and as a result of the gradual removal of obstructions to navigation.

During the past season of navigation there were four large packets running regularly between St. Louis and St. Paul, making in all six passages of the rapids per week. These packets carried a large amount of freight and a great number of passengers, and the records show that the passenger business, at least, is increasing year by year. More frequent trips were made by local packets and excursion boats, and raft-boats in large numbers were continually crossing.

Considering the case of the large packets, it appears that during the portion of the season when a favorable stage of water prevailed the delays at the rapids were comparatively few, the time-tables being so arranged that the boats reached Rock Island or Le Claire early in the day. Later in the season, when the river was low at all points and very regular time impracticable, especially when the towing of barges was necessary, the delays were more frequent; but it is impossible to estimate the amount of such delays and their effect on the business of the packets. In a letter received from Mr. E. M. Dickey, general superintendent of the Diamond Jo Packet Company, after giving a record of delays, as shown by the logs of the steamers, he says:

This report appears very good, as far as it goes, but we are not able to give any estimate of the amount of business lost on account of rapid runs, made in order to reach the rapids. For example, our steamers, on coming down-stream, begin to figure on making the rapids as soon as they leave St. Paul, and frequently miss a great many landings and a great deal of business in order to get over the rapids without being delayed by night. The same is frequently true of our up-stream trips. Again, after it has been conclusively shown to the officers of the boats that they can not by any means make the rapids at the time desired, they will then saunter along and "kill time" and arrive at Davenport or Le Claire, say, at daylight on a morning instead of arriving at 10 or 12 o'clock the night before, as they might have done.

The cost of extra pilotage for each packet running for the full season is estimated at $400 per year. The cost for extra fuel, especially when barges are being towed, and for occasional hire of extra tow-boats, are items of importance, but they can not well be determined from data available.

It can not be ascertained that any extra insurance rate is charged for additional risk on Rock Island Rapids.

The records do not show that accidents are more frequent on the rapids since their improvement than on some other portions of the river. This immunity from accidents is due, to a large extent, to the employment of skillful special pilots and the making of the passages over the rapids, as a rule, under the most favorable circumstances.

TIME REQUIRED FOR PASSAGE OVER THE ROCK ISLAND RAPIDS AND THROUGH THE DES MOINES RAPIDS CANAL.

The comparative advantages of canal and open-channel improvement as regards time of passage of boats, etc., have a bearing upon the questions presented for the consideration of the Board. The Des Moines and Rock Island Rapids are of about the same length and have about the same fall. In the first case the natural channel through the rock bottom is very shoal throughout its entire length, while in the second

case the shoal places are only found at the chains, the connecting pools having a sufficient depth for all purposes of navigation. These differences of conditions led to different plans of improvement. The most economical method at the Des Moines Rapids was by a canal 7½ miles in length and 3½ miles of open-channel improvement, giving a depth of 5 feet at extreme low water. At the Rock Island Rapids the method of open-channel improvement was adopted as being the most economical, so long as a depth of 4 feet at low water was sufficient for the needs of navigation.

At the Des Moines Rapids all rafts and many boats use the channel on the rapids whenever the stage of water permits; at other times they are obliged to use the canal.

The canal records show that single boats, as a rule, require about the same time to ascend and about one-half the time to descend the rapids as is needed, under the most favorable circumstances, for the passage of the canal in either direction. With two barges in tow the time in canal is about doubled, and with three barges about trebled. On the rapids, unless the tow-boat is deficient in power, less time will, as a rule, be required with two barges for ascending; descending, the barges will add but little to the time of the single boat.

Under favorable circumstances rafts of lumber occupy from eight to ten hours and rafts of logs not less than thirty-six hours in passing through the canal, the great delay being caused by the necessity of breaking up into pieces suitable for lockage the immense rafts, some being 300 by 600 feet. The times given do not include the additional delay due to breaking up before entering canal and making up after leaving. If a number of rafts arrive at the canal at about the same time during low water, some of them may be detained a week or more. When the rafts can be taken over the rapids they can follow each other closely, and but a few hours are required for the passage. Lumbermen estimate that the extra expense of moving rafts down the river, when it is necessary to use the canal, is about 20 per cent.

The steam-launch *Lucia*, 65 feet long, occupied one and a half hours in passing through the 7½ miles and two of the three locks of the Des Moines Rapids Canal, and thirty-six minutes in ascending the 3½ miles of the open canal from the guard-lock to Montrose. The fall in this 3½ miles of river is about 4 feet, and for a part of the distance the slope exceeds 2 feet to the mile, which gives a measured current of 2.6 miles per hour. The speed of the launch averages 5.6 miles through the canal and locks, and 5.08 miles per hour against the current of the river. With a larger boat the speed in the first case would be less and in the second case greater.

Packets occupy two to two and a half hours in ascending the Rock Island Rapids, and from one to one and a half hours in descending. Considering the length of canal necessary for overcoming the Rock Island Rapids, the time each way for single boats, even in a canal of considerable width and depth, would probably be not less than three hours.

Tow-boats with two or three barges have some difficulty at times with the current of Rock Island Rapids for short stretches, but the time now taken in ascending is, as a rule, less than would be required in passing through a canal 13½ miles long; if more barges were towed and double trips necessary, the advantage in time would possibly be in favor of a canal. On descending trips, the time on the open channel would not be much greater for tows than for single boats.

Rafts are now taken over the Rock Island Rapids in daylight in from

eight to ten hours. Making allowance for delays at night, the average time, under most unfavorable conditions, strong winds excepted, can be taken as not to exceed one day. The extra expense of running rafts over the rapids is given as from $65 to $110, while the average cost of a day's delay is from $65 to $100. As rafts can now be taken over the Rock Island Rapids at all stages of water at much less expense and in much less time than would be permissible with any canal, it is evident that a canal would not be used for rafts under any circumstances, unless possibly, when they were destined for Moline; hence a detailed consideration of probable time required by rafts in passing through the canal is unnecessary.

In deciding "as to the best and most economical plan of improving the river at the Rock Island Rapids in the interest of commerce and navigation," the classes of navigation must be considered separately.

(1) *Rafting.*—This interest, as has been shown, is at present the greatest in magnitude of any on the Upper Mississippi. Rafts and raft-boats do not require any greater depth of water than is now furnished by the channel over the rapids. There is some slight risk and extra expense attendant upon the passage of rafts during low water, but delays are not very serious, and the rapids, even in their present condition, are much to be preferred for this class of navigation to any canal that can be built. If canal navigation were furnished in addition to the open channel improvement, raft-boats, under certain conditions of wind and currents, and, possibly, when a large number of rafts were descending, might occasionally use the canal, but such additional facilities, so far as raft boats are concerned, are not sufficiently necessary to justify the expense of a canal. While the present facilities for the passage of the rapids by rafts and raft-boats are good, they can be made much better by such additional work as will serve to give a wider, more direct, and a more plainly-marked channel, making navigation by day easier and safer and navigation by night practicable.

(2) *Packets without tows.*—Until a greater depth than 4 feet at low water is secured at all points above and below the Rock Island Rapids, a greater depth, while it would be advantageous, is not absolutely necessary for packet navigation on the rapids; and, considering the rate at which the radical improvement of the Upper Mississippi is progressing, it will be a number of years yet before an additional depth on the rapids will become a necessity. The passage of the large packets over the rapids is now attended with some extra expense for fuel and special pilotage, and probably with some slight risk even in day-time; but the delay at night and at other occasional times when conditions are not favorable for a safe passage is the most important matter to be considered at present in connection with the effect of the rapids on packet navigation. These delays are expensive, and the interests involved justify such work as will permit the packets to cross the rapids safely day or night. The further improvement of the present navigable channel necessary in the interest of raft navigation, together with a slight deepening and widening at a few additional points, will, it is thought, furnish a channel navigable for packets by night as well as by day; and while a canal, if it existed, would undoubtedly be occasionally made use of, its necessity for packet use does not seem sufficiently great at the present time to justify its construction. But while a depth of 4 feet at low water and such improvement of the natural channel as is now recommended may be sufficient for a number of years to come, it is certain that in the future the interests of commerce and navigation will require a channel with less current on the chains, a depth of not less than 6 feet at low

water, and a width of probably not less than 400 feet, or a canal aroun the rapids giving similar facilities, for use when the river may be at low stage. Of these two plans for securing a 6-foot navigation at th rapids, that of a canal promises more positive results and is less ex pensive.

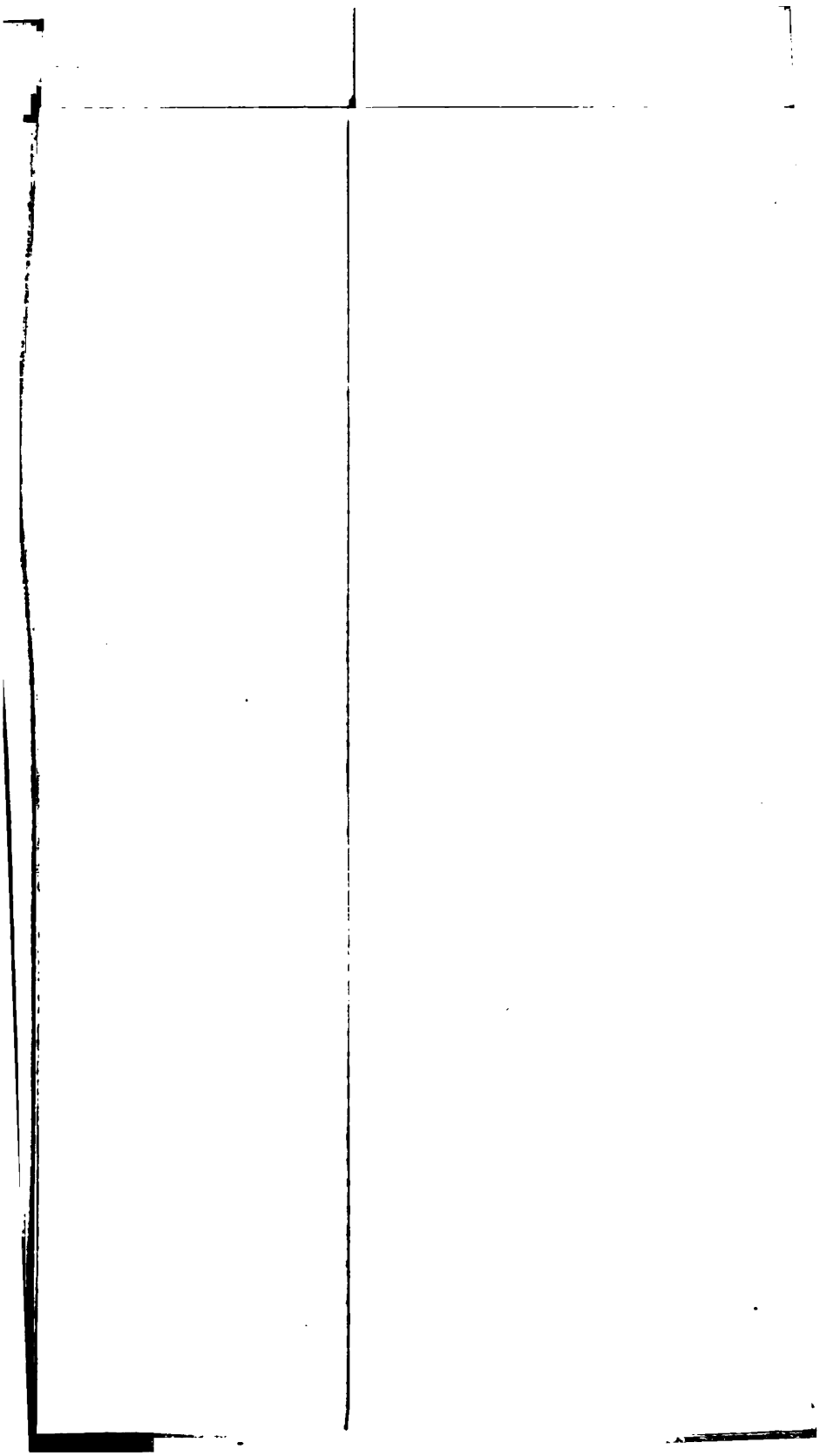
3. *Packets or tow-boats with barges, etc.*—During certain low stages o the river the available depths at many points necessitate the carryin of freight on barges, towed either by the regular packets or special tow boats. The swift current on some of the chains makes the ascent o the rapids by large tows tedious at times. The work needed for facili tating raft and packet navigation will overcome some of the difficultie experienced by tows above the head of Moline Chain, excepting possi bly at Sycamore Chain; but from the head of Moline Chain to the foo of the rapids, where there is a fall at low stages of nearly 7.5 feet in miles and about 4¾ feet in 1¼ miles, such general increase of depth o reduction of current by channel-works as will make this section of th rapids easy of navigation at all times by large tows does not seem to b practicable even at great expense, and it is this class of navigatio which is most seriously affected, both as regards delays and additiona expense, by the conditions existing at the Rock Island Rapids.

A canal 2.9 miles in length around Moline and Lower Chains, bein Canal No. 2, previously referred to, has been projected at an estimate cost of from $1,111,934.12 to $1,531,662.22, and it is thought that suc a canal may be necessary when the towing interests become sufficientl great, or when it may be positively shown that the interests of com merce and navigation are being seriously affected by the difficulty moving heavy tows up the rapids; but the records would indicate tha at the present time these towing interests are not very large, and tha while the occasional difficulties met with by individual tows are con siderable, the total extra expense incurred as a result of the swiftnes of current is probably not sufficiently great to justify the immediat construction of this canal. The remarks made with regard to a 6-foo navigation for single packets apply with even greater force to this clas of navigation.

The general conclusions of this Board are that the present navigabl channel of the Rock Island Rapids should be improved to so full a extent, limiting depth to 4 feet at low water, as to make a passage ove them by day or night reasonably safe and as easy as the natural cond tions permit, and it is thought that such a result will be accomplishe by the work referred to in the extracts taken from the project of th engineer officer in local charge of the work, and it is also thought tha the present interests of commerce and navigation justify such an e penditure as is involved in the execution of such work.

When the towing and freighting interests of the river become sufficient magnitude, or when the interests of commerce are shown t be materially injured by the difficulties in ascending the navigabl channel of the rapids, the construction of a canal from the head Moline Chain to the foot of the rapids may become necessary; and is only by means of such a canal that the excessive current on this se tion of the rapids can be fully overcome.

When the improvement of the Upper Mississippi River furnishes depth of 6 feet at low water at points below the Rock Island Rapid the construction of a canal from Moline to Rapids City in the bed the river, as shown on accompanying tracing, will provide at less e pense, and in a more desirable manner, for navigation during the tim that the additional 2 feet of depth may be required.



A detailed estimate of the cost of canal construction is attached hereto, and a tracing, showing the location of the proposed canals, and of the channel improvements recommended, is transmitted herewith.

All of which is respectfully submitted.

O. M. POE,
Colonel of Engineers.
A. MACKENZIE,
Major of Engineers.
W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Approximate estimate for canal around the Rock Island Rapids, Mississippi River, accompanying report of January 16, 1889, of Board of Engineer Officers constituted by Special Order No. 59, Headquarters Corps of Engineers, October 29, 1888.

Miles from Rapids City.	Rock excavation.		Bal. rock excavated included in riprap estimate.	Embankment—earth, 40 cents; riprap, $2.50; paving, $3.				Locks.		Cost of sluices and bulkheads.	Total cost.
	Cubic yards.	Cost.		Earthwork.	Riprap.	Paving.	Total cost.	No.	Cost.		
				Cu. yds.	*Cu. yds.*	*Cu. yds.*					
1				98,737	22,477	7,904	$119,399.30	1	$278,700	$36,448	$434,547.30
2	32,112	$128,448		122,050	27,623	8,758	144,151.50	....	.....	.....	272,599.50
3	4,237	16,948		152,454	34,353	9,941	176,687.10	....	.....	.....	193,635.10
4				134,032	30,267	9,267	157,081.30	....	.....	.....	157,081.30
5				137,027	30,949	9,467	160,584.30	....	.....	.....	160,584.30
6				16,908	3,909	1,619	21,392.70	....	.....	.....	21,392.70
7				41,424	9,401	3,144	49,504.10	....	.....	.....	49,504.10
8				115,757	26,232	8,543	137,511.80	....	.....	.....	137,511.80
9				123,123	27,880	8,908	145,673.20	....	.....	.....	145,673.20
10				112,102	25,412	8,404	133,582.80	....	.....	.....	133,582.80
11	58,142	295,710		98,966	22,294	6,355	114,386.40	1	278,700	36,448	725,244.40
12	16,172	32,344		161,725	36,367	9,943	185,436.50	....	.....	.....	217,780.50
13				167,530	37,974	8,891	188,620.00	....	.....	.....	188,620.00
14	7,830	39,150		129,963	29,239	6,500	144,582.70	1	234,440	.....	518,172.70

Cost of upper canal	$2,049,370.50
Cost of rock excavation in channel connecting canals	295,710.00
Cost of lower canal, with one lock	1,010,849.20
Land damages	12,000.00
Add 10 per cent. for contingencies	336,792.97
Total	3,704,722.67
Additional cost of canal with two locks	186,387.30
Additional cost for location between Rock and Benham's islands	233,340.80

A A 3.

IMPROVEMENT OF DES MOINES RAPIDS, MISSISSIPPI RIVER.

At the beginning of the year there was on hand a balance of $25,240.16, but of this amount $25,000 was applicable to the construction of a pier below the Des Moines Rapids Canal. The river and harbor act of August 11, 1888, appropriated $35,000 for continuing work on the rapids, and authorized the establishing of a floating boom to connect outer canal wall with upper draw-rest of the bridge at Keokuk, in lieu of the fixed pier formerly provided for. This boom was completed and put in position during the past year at a total cost of $13,500, leav-

ing $11,500 of the amount originally set aside for a pier to be used for work under the approved project.

A project for the construction of this floating boom, with plans, was submitted August 24, 1888, and approved September 7, 1888.

A partial project, covering the raising of lock-walls and rock excavation, was submitted August 24, 1888, and approved September 6, 1888.

A full project for the expenditure of the $47,194.41 at the time available was submitted February 28, 1889, and approved March 15, 1889. The work contemplated by this project was as follows:

1. For raising lock-walls of lower lock, as specified in project of August 24	$7,963.45
2. For office building at lower lock	5,000.00
3. For sluice in canal bank at Lamallee's Creek	10,391.82
4. For rock excavation above guard-lock, as specified in project of August 24	1,200.00
5. For completing sluice at Price's Creek	1,000.00
6. For riprap face-stone, now under contract	4,500.00
7. For protecting outside slope of canal embankment, stone and labor	13,750.00
8. For completing floating boom	800.00
9. For contingencies of engineering, etc	2,589.14
	47,194.41

The work carried out during the year has been the construction of floating boom, the removal of some rock above grade in open canal above Nashville, the commencement of the construction of the sluice at Sandusky, and the raising of lock-walls at lower lock.

Plans for an office building have been prepared and a contract for the work will be let during July, 1889.

Contracts were made during the year with the following parties:

1. Patterson Brothers, Keokuk, Iowa, dated September 27, 1888, for furnishing stone at Des Moines Rapids Canal.
2. W. J. Broatch, Omaha, Nebr., dated October 5, 1888, for furnishing and delivering at Keokuk, Iowa, about 27,000 pounds round and flat bar-iron.
3. Carson & Rand, Keokuk, Iowa, dated October 6, 1888, for furnishing and delivering at Keokuk, Iowa, about 425,000 feet B. M. of timber.
4. Patterson Brothers, Keokuk, Iowa, dated April 27, 1889, for furnishing stone at Des Moines Rapids Canal.
5. Meacham & Wright, Chicago, Ill., dated May 4, 1889, for furnishing hydraulic cement at the Des Moines Rapids Canal.

The work remaining to be done to complete this work in accordance with the project that has received the approval of Congress is the completion of sluices for carrying off the muddy water of Price's and Lamallee's creeks, completion of work of raising lock-walls of lower and middle locks, removal of a small amount of rock above grade in open canal, completion of paving of canal embankment, building an office at the lower lock, and completing the lock grounds. Most of this work is provided for by the funds now available and will be completed this season.

There is required to complete this work in accordance with approved project the sum of $22,000.

ABSTRACT OF APPROPRIATIONS.

By act approved—	
June 23, 1866	$200,000
March 2, 1867	500,000
July 25, 1868 (allotment)	300,000
April 10, 1869 (allotment)	178,200
December 23, 1869	200,000
July 11, 1870	400,000
January 18, 1871	341,000
March 3, 1871	250,000
June 10, 1872	400,000

By act approved—	
March 3, 1873	$400,000
June 23, 1874	400,000
March 3, 1875	480,000
August 14, 1876	230,000
June 18, 1878 (allotment)	62,500
March 3, 1879	25,000
June 14, 1880	20,000
March 3, 1881	25,000
By act passed August 2, 1882	30,000
By act approved July 5, 1884	50,000
By act approved August 5, 1886	26,250
By act of August 11, 1888	35,000
Total	4,552,950

Money statement.

July 1, 1888, amount available		$25,240.16
Amount appropriated by act of August 11, 1888		35,000.00
		60,240.16
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$26,343.85	
July 1, 1889, outstanding liabilities	710.18	
July 1, 1889, amount covered by existing contracts	12,858.88	
		39,912.91
July 1, 1889, balance available		20,327.25
Amount (estimated) required for completion of existing project		22,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		22,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 p. m., September 26, 1888, for furnishing and delivering at Keokuk, Iowa, about 425,000 feet, B. M., of pine timber.

Articles.	No. 1. Burlington Lumber Co., Burlington, Iowa.		No. 2. S. & J. C. Atlee, Fort Madison, Iowa.		No. 3. D. B. Stevens & Co., Cassville, Wis.	
	Per M.	Amount.	Per M.	Amount.	Per M.	Amount.
668 pieces 6 inches by 8 inches by 16 feet, containing 42,752 feet, B. M	$13.50	$577.15	$13.75	$587.84	$14.00	$598.52
200 pieces 10 inches by 12 inches by 6 feet, containing 12,000 feet, B. M	14.00	168.00	14.50	174.00	14.00	168.00
200 pieces 8 inches by 10 inches by 6 feet, containing 8,000 feet, B. M	13.50	108.00	13.75	110.00	14.00	112.00
363 pieces 3 inches by 12 inches by 16 feet, containing 17,424 feet, B. M	14.00	243.93	14.25	248.29	14.00	243.93
100 pieces 10 inches by 12 inches by 13 feet, containing 13,000 feet, B. M	14.50	188.50	15.00	195.00	14.00	182.00
732 pieces 12 inches by 12 inches by 16 feet, containing 140,544 feet, B. M	14.50	2,037.88	15.00	2,108.16	15.00	2,108.16
32 pieces 12 inches by 12 inches by 8 feet, containing 3,072 feet, B. M	14.00	43.00	14.00	43.00	15.00	46.08
130 pieces 12 inches by 12 inches by 32 feet, containing 49,920 feet, B. M	20.00	998.40	21.00	1,048.32	23.00	1,148.16
479 pieces 12 inches by 12 inches by 24 feet, containing 137,952 feet, B. M	18.50	2,552.11	18.50	2,552.11	19.00	2,621.08
2 pieces 8 inches by 10 inches by 10 feet, containing 134 feet, B. M	14.00	1.88	13.50	1.81	14.00	1.88
2 pieces 8 inches by 12 inches by 16 feet, containing 256 feet, B. M	14.50	3.71	14.50	3.71	14.00	3.58
Total	.....	6,922.58	.....	7,072.24	.....	7,233.39

Abstract of proposals received and opened by Major A. Mackenzie, etc.—Continued.

Articles.	No. 4. Quincy Saw-Mill Co., Quincy, Ill.		No. 5. Knapp, Stout & Co., Fort Madison, Iowa.		No. 6. Carson & Rand, Keokuk, Iowa.	
	Per M.	Amount.	Per M.	Amount.	Per M.	Amount.
668 pieces 6 inches by 8 inches by 16 feet, containing 42,752 feet, B. M.	$15.00	$644.28	$13.50	$577.15	$13.50	$577.15
200 pieces 10 inches by 12 inches by 6 feet, containing 12,000 feet, B. M.	17.00	204.00	14.50	174.00	14.00	168.00
200 pieces 8 inches by 10 inches by 6 feet, containing 8,000 feet, B. M.	16.00	128.00	14.00	112.00	13.50	108.00
363 pieces 3 inches by 12 inches by 16 feet, containing 17,424 feet, B. M.	16.00	278.78	15.00	261.36	13.75	239.58
100 pieces 10 inches by 12 inches by 13 feet, containing 13,000 feet, B. M.	17.00	221.00	15.00	195.00	14.75	185.25
732 pieces 12 inches by 12 inches by 16 feet, containing 140,544 feet, B. M.	17.00	2,389.25	16.00	2,248.70	14.50	2,037.88
32 pieces 12 inches by 12 inches by 8 feet, containing 3,073 feet, B. M.	17.00	52.22	16.00	49.15	14.00	43.00
130 pieces 12 inches by 12 inches by 32 feet, containing 49,920 feet, B. M.	27.50	1,372.80	25.00	1,248.00	20.00	998.40
479 pieces 12 inches by 12 inches by 24 feet, containing 137,952 feet, B. M.	22.50	3,103.92	20.00	2,759.04	18.50	2,552.11
2 pieces 8 inches by 10 inches by 10 feet, containing 134 feet, B. M.	16.00	2.14	15.00	2.01	15.00	2.01
2 pieces 8 inches by 12 inches by 16 feet, containing 256 feet, B. M.	17.09	4.35	16.00	4.09	14.50	3.71
Total	.....	8,397.74	.....	7,630.50	.....	6,915.00

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 p. m., September 26, 1888, for furnishing and delivering at Keokuk, Iowa, about 27,000 pounds round and flat bar-iron.

Articles.	No. 1. W. J. Broatch, Omaha, Nebr.*		No. 2. Ewald Iron Co., St. Louis, Mo.	
	Per pound.	Amount.	Per pound.	Amount.
	Cents.		*Cents.*	
13,600 pounds iron, ½ inch, round, common	2	$272.00	2	$272.00
2,950 pounds iron, ⅝ inch, round, common	2.1	61.95	2.2	64.90
5,300 pounds iron, 1 inch, round, common	1.9	100.70	1.85	98.05
188 pounds iron, 1¼ inches, round, common	1.9	3.57	1.85	3.48
1,570 pounds iron, 2 inches, round, common	2	31.40	2	31.40
368 pounds iron, 1½ inches, round, refined	2.4	8.83	2.25	8.28
24 pounds iron, 2 inches, round, refined	2.5	.60	2.45	.59
1,000 pounds iron, flat bar, 3 inches by 1 inch, refined	2.4	24.00	2.25	22.50
800 pounds iron, flat bar, 4 inches by 1½ inches, refined	2.4	19.20	2.65	21.20
60 pounds iron, flat bar, 2 inches by ⅜ inch, refined	2.4	1.44	2.25	1.35
90 pounds iron, flat bar, 2 inches by ½ inch, refined	2.4	2.16	2.25	2.02
140 pounds iron, flat bar, 4 inches by ½ inch, refined	2.4	3.36	2.25	3.15
270 pounds iron, flat bar, 6 inches by ⅜ inch, common	1.95	5.26	1.9	5.13
6 kegs spikes, 7 inches by ½ inch, 90 pounds	3.5	31.50	.....	.....
610 nuts, hexagon, for 1-inch bolts, 450 pounds	2.75	12.37	.....	.....
610 washers, cut for 1-inch bolts, 100 pounds	3.6	3.60	.....	.....
Total	.....	581.94	.....	.....

*Accepted and formal contract made.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., April 18, 1889, at 2 p. m., for furnishing stone for use at the Des Moines Rapids Canal.

No.	Name and address of bidder.	Articles.	Per cubic yard.
1	Fort Madison and Appanoose Stone Company, Fort Madison, Iowa.	295 cubic yards face stone	$8.47
		133 cubic yards backing stone	4.90
		2,100 cubic yards riprap face stone	1.98
		2,000 cubic yards rubble filling	.78
		Total amount of bid	8,299.35
2	Patterson Bros., Keokuk, Iowa	295 cubic yards face stone	8.00
		133 cubic yards backing stone	3.00
		2,100 cubic yards riprap face stone	2.00
		2,000 cubic yards rubble filling	.65
		Total amount of bid	8,259.00

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 p. m., September 26, 1888, for furnishing stone for use at the Des Moines Rapids Canal and Dry Dock, and delivering the same on United States barges in canal or in the river within 5 miles of the head of the canal, or 1 mile of its foot.

No.	Name and address of bidder.	Articles.	Per cubic yard.	Amount.
1	A. J. Whitney, Rock Island, Ill	300 cubic yards face stone	$10.50	$3,150
		100 cubic yards backing stone	6.00	600
		3,000 cubic yards riprap face stone	2.30	6,900
		Total amount of bid		10,650
2	Patterson Bros., Keokuk, Iowa*	300 cubic yards face stone	10.00	3,000
		100 cubic yards backing stone	6.00	600
		3,000 cubic yards riprap face stone	2.25	6,750
		Total amount of bid		10,350

*Accepted; formal contract made.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., April 18, 1889, at 2 p. m., for hydraulic cement for use at the Des Moines Rapids Canal.

No.	Name and address of bidder.	Cement, natural, 600 barrels, per barrel of 300 pounds.		Remarks.
		In barrels.	In bags.	
1	Meacham & Wright, Chicago, Ill	$1.16	$0.95	Utica cement.
2	James McNamara, Keokuk, Iowa	1.09	.98½	Bids as made, 87 cents per barrel of 265 pounds.

A A 4.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL.

The Des Moines Rapids Canal was open for navigation during the past year two hundred and forty-five days, during which time there passed through it 1,022 steam-boats and 288 barges, carrying 22,880 passengers, 50,008 tons of merchandise, and 381,559 bushels of grain. There also passed through 118,508,045 feet of lumber, 26,333,320 feet of logs, 50,221,099 shingles, and 37,413,810 lath.

The expenses of operating and caring for the Des Moines Rapids Canal during past year have been $38,885.37. These expenses are now provided for by an indefinite appropriation made by act of Congress of March 3, 1881.

Tables are given herewith showing details of expenditure and traffic.

The operating and care of the canal are in the immediate charge of Mr. M. Meigs, United States civil engineer, whose report is appended.

ABSTRACT OF APPROPRIATIONS.

By act approved—	
April 30, 1878	$7,500
June 18, 1878 (allotment)	32,500
March 3, 1879	40,000
June 14, 1880	30,000
March 3, 1881, for fiscal year ending—	
June 30, 1882	45,000
June 30, 1883	75,000
June 30, 1884	47,000
June 30, 1885	40,500
June 30, 1886	43,000
June 30, 1887	44,000
June 30, 1888	42,000
June 30, 1889	39,000
Total	485,500

Money statement.

July 1, 1888, balance on hand	$1,047.40
June 30, 1889, amount drawn from Treasury under indefinite appropriation	39,000.00
	40,047.40
June 30, 1889, amount expended during fiscal year	38,885.37
June 30, 1889, balance on hand	1,162.03

Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1889.

Month.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.
1888.								
July	$375.00	$5.00	.....	$380.00	$1,513.00	$93.90	$647.84	$2,254.74
August	375.00	.....	$43.39	418.39	1,515.00	148.31	292.53	1,955.84
September	.....	.....	63.65	63.65	.....	186.76	64.88	251.64
October	750.00	8.85	96.00	854.85	2,765.84	225.51	1,301.75	4,293.10
November	.....	.....	.....	.....	25.80	349.12	26.19	401.11
December	.....	.....	.....	.....	2,688.83	106.16	335.36	3,130.35
1889.								
January	640.00	.....	9.04	649.04	1,342.50	26.60	170.47	1,539.57
February	375.00	3.10	1.70	379.80	1,400.00	142.36	143.38	1,685.74
March	375.00	.80	83.60	459.40	1,471.49	208.19	219.71	1,899.39
April	640.00	9.05	.....	649.05	1,438.33	124.29	35.05	1,597.67
May	.....	.....	.....	.....	1,441.00	604.87	166.70	2,212.57
June	220.00	.....	21.44	241.44	1,640.00	61.90	285.34	1,987.24
Total	3,750.00	26.80	318.82	4,095.62	17,241.79	2,277.97	3,689.20	23,208.96

Expenditures for operating and care of Des Moines Rapids Canal—Continued.

Month.	Dredging canal.				Grand total.
	Labor.	Supplies.	Current repairs.	Total.	
1888.					
July	$1,571.00	$847.12	$73.64	$2,491.76	$5,126.50
August	1,635.82	669.16	355.87	3,660.80	4,975.03
September	.....	190.33	163.66	353.99	669.28
October	1,637.42	878.79	208.42	2,724.63	7,872.58
November	.....	402.57	168.67	571.24	972.35
December	.....	.....	426.80	426.80	3,557.15
1889.					
January	.....	.....	118.62	118.62	2,307.23
February	.....	3.05	88.74	91.79	2,157.33
March	.....	138.79	616.73	755.52	3,114.31
April	729.31	425.21	63.85	1,218.37	3,465.09
May	.....	28.39	175.02	203.41	2,415.98
June	.....	4.71	19.15	23.86	2,252.54
Total	5,573.56	3,528.06	2,479.17	11,580.79	38,885.37

Traffic statement of the Des Moines Rapids Canal for the year ending June 30, 1889.

Month.	Boats up.	Boats down.	Barges up and down.	Passengers.	Merchandise.	Grain.
1888.					*Tons.*	*Bushels.*
July	112	36	22	7,707	4,352	29,282
August	122	62	41	6,175	6,717	24,833
September	54	57	22	887	5,380	16,203
October	43	51	27	434	2,454	7,135
November	18	16	1	40	405	6,550
1889.						
March	8	11	24	28	266	3,800
April	64	39	43	403	7,982	100,200
May	76	57	29	826	11,593	90,830
June	125	65	79	6,390	10,859	102,726
Total	628	394	288	22,880	50,008	381,559

Month.	Lumber.	Logs.	Shingles.	Lath.	No. of lockages.
1888.	*Feet.*	*Feet.*	*Number.*	*Number.*	
July	800,000	.....	443,000	172,000	167
August	10,328,664	.....	5,762,500	2,808,000	215
September	35,297,322	10,533,200	12,103,250	12,103,250	359
October	41,537,722	6,074,000	17,867,099	11,915,380	471
November	3,348,232	1,779,000	1,505,000	723,600	64
1889.					
March	.....	.....	.....	.....	18
April	3,648,692	650,000	455,000	510,800	178
May	20,074,133	2,910,000	9,605,250	5,249,750	233
June	3,473,280	4,287,120	2,480,000	3,931,030	236
Total	118,508,045	26,333,320	50,221,099	37,413,810	1,941

Comparative expenditures for operating and care of Des Moines Rapids Canal for fiscal years 1882 to 1889.

Year.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.
1882	$3,710.00	$161.69	$550.62	$4,422.31	$21,122.70	$1,654.06	$1,946.03	$24,722.79
1883	4,821.12	289.56	449.52	5,560.50	25,813.49	2,216.87	3,203.01	31,233.28
1884	5,045.22	209.12	665.62	5,919.96	17,654.23	4,344.51	1,291.20	23,289.94
1885	5,015.00	245.41	573.88	5,834.19	17,615.97	1,995.92	5,237.88	24,849.77
1886	5,225.00	209.12	432.10	5,866.22	17,731.76	2,226.23	5,552.87	25,510.86
1887	4,375.00	85.19	424.48	4,884.67	18,326.23	2,752.89	3,775.59	24,854.62
1888	4,870.00	154.04	481.70	5,505.74	16,892.82	1,942.94	7,972.29	26,808.05
1889	3,750.00	26.80	313.82	4,095.62	17,341.79	2,277.97	3,569.20	23,208.96

Year.	Dredging canal.					Miscellaneous.	Grand total.
	Labor.	Supplies.	Repairs.	Contract.	Total.		
1882	$2,340.43	$572.09	$46.58	$14,080.39	$17,039.49	*$68.75	$47,053.34
1883	4,765.93	1,538.80	598.04	30,666.17	37,568.94	*3,564.07	77,926.70
1884	7,485.45	4,789.32	1,262.02	.....	13,536.79	*536.78	43,283.42
1885	3,353.12	8,580.69	1,888.78	.....	13,822.54	.....	44,506.50
1886	4,984.55	3,017.49	3,530.41	.....	11,532.45	.....	43,009.53
1887	6,149.45	2,810.12	2,453.98	.....	12,413.55	.....	42,152.84
1888	5,084.77	2,267.62	1,808.85	.....	9,161.24	†1,327.32	42,802.35
1889	5,573.56	3,528.06	2,479.17	.....	11,580.79	.....	88,885.37

* Machine-shop. † Boom above guard-lock.

Comparative traffic statement, showing the total traffic that has passed through the canal since its opening in 1877, by fiscal years ending June 30.

Fiscal year.	Steam-boats.	Barges.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Laths.	Shingles.	Lockages at one lock.
				Tons.	*Bushels.*	*Feet.*	*Feet.*	*Number.*	*Number.*	*No.*
1878	670	548	.....	53,346	737,415	25,000,000	.....	4,000,000	3,700,000	824
1879	802	454	5,008	64,658	2,192,642	33,347,612	8,086,000	8,721,796	11,749,000	1,564
1880	967	651	13,231	78,989	2,197,469	21,832,478	13,160,960	27,863,640	30,561,000	2,497
1881	840	276	10,003	44,962	1,151,092	52,256,235	11,013,410	11,657,655	15,091,000	1,339
1882	760	444	8,588	29,043	781,817	17,150,011	4,475,000	3,112,825	4,885,250	2,202
1883	1,107	705	9,192	43,359	729,174	13,093,325	1,040,000	11,558,000	4,435,000	1,353
1884	913	245	13,057	54,215	470,580	57,018,151	9,599,764	15,924,645	25,182,250	1,908
1885	889	169	13,065	54,120	776,432	43,119,797	2,779,670	13,473,205	25,018,750	1,270
1886	784	218	22,221	56,001	465,681	22,769,823	3,195,360	4,302,800	8,253,000	755
1887	990	318	20,797	52,815	366,432	178,754,876	24,827,000	19,961,781	90,450,922	1,717
1888	595	235	8,330	33,160	143,037	166,827,752	34,505,000	83,642,450	49,848,840	1,749
1889	1,022	288	22,880	50,008	381,559	118,508,045	26,333,320	50,221,099	37,413,810	1,941

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1889.

MAJOR: I have the honor to submit the following report on "operating and care of Des Moines Rapids Canal" for the fiscal year ending June 30, 1889:

The canal was open to navigation 245 days and closed 120 days.

The great flood of 1888 gradually subsided, and in the fall of 1888 the usual low-water stage came on in September, but, as a rule, the last fiscal year has been marked by a very good boating stage of water nearly all the time.

REPAIRS TO CANAL EMBANKMENT.

No work on the embankment has been done during past year. The weak places below Nashville remain as they were at date of last report. They are safe, except in case of another great flood. Should such an one occur in the future, the embankment will have to be re-enforced on the inside, but it is not at present necessary.

At the guard-lock the macadam was removed from the lock-grounds and taken to the dry-dock for making concrete. The earth taken from the embankment above the dry-dock was used to replace this macadam, greatly improving the appearance of the lock-grounds.

DREDGING CANAL.

The canal-dredge was employed from July 1, 1888, to September 18, 1888, from October 5 to 30, 1888, and from April 1 to 18, 1889, at various points in the canal. In September the entrance to dry-dock was dug and 5,158 cubic yards mud removed from the dry-dock prism.

Material removed:

Vicinity of Sandusky	cubic yards..	60,416
Vicinity of Price's Creek	do....	18,890
Vicinity of Lower Lock	do....	6,971
Total		86,278

The dredge was worked night and day in the canal, and though the machine has been a great portion of the time away from Keokuk, the output for the year has been greater than in any other year, except one, when a contractor, with two dredges and the United States dredge together, removed 113,000 cubic yards.

The night and day working of the dredge seems very satisfactory, and practically gives us two machines, as compared with day work only.

The four dump-boats were decked and repaired during the winter, to fit them for another season's work, but will require extensive rebuilding next winter, as they are now five years old, and have seen very constant and hard service.

REPAIRS TO PLANT.

The usual current repairs were made from time to time, including the work on the four dumps above referred to. The fence at the middle lock had to be again partially rebuilt, owing to the rotting off of the posts.

BOUNDARIES TO CANAL PROPERTY.

The remarks made in the last annual report apply in all respects for the fiscal year ending June 30, 1889. Nothing further has been done.

REPAIRS TO LOCK GATES AND MACHINERY.

But little repair has been needed to the lock gates or machinery. The gates at the guard-lock will probably have to be rebuilt in the course of one or two years, more as they are out of water so much of the time in summer that decay proceeds faster in them than in the other gates.

MACHINE-SHOP.

During the winter four lock engineers and two carpenters have been busy on various repairs to canal and other plant. Two small dynamos, of 2,000 c. p., were built for United States launches, the dredge-engine was thoroughly overhauled, and all her machinery put in good order.

The old wooden building, built originally of second-hand lumber, is becoming rotten and unfit to carry the shafting, etc. This building should be replaced by a fire-proof structure, of brick or stone, for the safe storage of thousands of dollars worth of patterns and machinery, liable to be consumed at any time in the present inconvenient and inflammable wooden building.

It is estimated that $3,500 would provide a suitable structure with iron roof and shutters and a comparatively fire-proof pattern-loft over the machine-shop.

CAPSTANS AT THE LOCKS.

The large raft traffic that passes through the canal has developed the necessity for some means of facilitating the passage of the canal by these unwieldy tows. A steam

capstan at each lock would greatly increase the speed of passing through the locks, and could be supplied with steam from the lock-boiler which is, at the time these capstans would be in use doing nothing.

The manual labor of hauling rafts, 300 feet long and 75 feet wide, into and out of the locks, is so severe that the boats' crews become so worn out they are unable to work at night, and in consequence often lose much time and blockade the canal, when, were the severe labor removed, the work could go on continuously, thus increasing the capacity of the canal and relieving rafting of one of its heaviest taxes.

I estimate $650 for the cost of a suitable steam capstan at each lock or $1,950 for the three locks. These capstans are greatly desired by the lumbermen, and would be a proper addition to the canal plant.

BUSINESS OF THE CANAL.

The canal traffic does not appear as large as in some other years, owing to the good stage of water permitting boats to go outside. Nearly all the upward-bound traffic, however, has been through the canal.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

AA 5.

DRY-DOCK AT DES MOINES RAPIDS CANAL, MISSISSIPPI RIVER.

At the beginning of the fiscal year no funds were available for this work, but by the river and harbor act of August 11, 1888, the sum of $16,250 was appropriated for its completion. During the past year the grading and paving of the bottom of the dock was completed, the pump-house was b uilt, and pumps set up and the timber work of dock bottom nearly finished.

The dry-dock will be completed at an early day, with the funds now available, there remaining only the construction of a small amount of wing and slope walls and of timber work of the dock bottom. The large plant, owned by the United States and used in connection with the improvement of the Upper Mississippi River, will make use of the dock, and already, in its unfinished condition, it has proved of great service for repair and construction. The dock will also be of great benefit to the entire commerce of the river.

ABSTRACT OF APPROPRIATIONS.

By act passed August 2, 1882	$30,000
By act approved July 5, 1884	30,000
By act approved August 5, 1886	48,750
By act of August 11, 1888	16,250
Total	125,000

Money statement.

Amount appropriated by act of August 11, 1888		$16,250.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$14,017.55	
July 1, 1889, outstanding liabilities	225.00	
		14,242.55
July 1, 1889, balance available		2,007.45

A A 6.

HARBORS OF REFUGE ON LAKE PEPIN, AT STOCKHOLM, WISCONSIN.

My last annual report refers to the damage done to this pier at the time of the breaking up of the ice in the spring of 1888. After the water in Lake Pepin fell sufficiently to permit of a thorough examination, it was found that, while most of the material could be utilized, about 4 feet of the top of the pier was so broken up as to necessitate rebuilding.

Repairs were commenced August 23 and completed early in November, 1888. Sloping sides were substituted for vertical sides of superstructure, and the angle between cribs and bed of lake was filled in with brush and rock. As the ice can now slide up on this pier, as in case of the pier at Lake City, it is thought that the safety of the pier for some time to come is assured.

At the time of making my last annual report, before the condition of the injured pier was thoroughly known, it was thought that an additional appropriation would be necessary for carrying out the necessary repairs; but, by careful management, the work was accomplished with the funds available.

Unless an extension of the work is deemed desirable, no further appropriation for this work is needed at the present time.

A balance of $139.47 is still on hand and will be used for small repairs.

ABSTRACT OF APPROPRIATIONS.

By act passed August 2, 1882	$10,000
By act approved July 5, 1884	15,000
Total	25,000

Money statement.

July 1, 1888, amount available	$5,929.06
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding June 30, 1888	5,789.59
July 1, 1889, balance available	139.47

A A 7.

PRELIMINARY EXAMINATION OF MOLINE CITY HARBOR, ILLINOIS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., December 7, 1888.

GENERAL: The river and harbor act of August 11, 1888, provides for a preliminary examination of "Moline City Harbor, Illinois," with a view to determining whether said harbor be worthy of improvement by the General Government. This examination, assigned to me by letter of the Chief of Engineers of August 28, 1888, having been completed, I have the honor to submit the following report thereon.

Under date of August 9, 1887, there was referred to me for report a letter dated August 2, 1887, and addressed to the Secretary of War by Hon. William H. Gest. This letter forwarded and commended a peti-

tion indorsed by the Moline city council, and presented to the Secretary of War by citizens of Moline. The letter and petition called for a survey "to determine the cost of improving the landing and harbor at the city of Moline so that the largest steam craft running on the Upper Mississippi may be able to land at the lowest stage of water." A specific plan and location for the landing was presented by the petition. A report upon the questions presented was submitted by me under date of January 25, 1888, much of which report is reproduced herein.

Upon receipt of notification that a further examination was required by act of Congress, I addressed a letter to the mayor of Moline, under date of September 13, 1888, calling attention to the object of the preliminary examination, referring to the former petition, and requesting any further available statistics and information. The reply was as follows:

OFFICE DEERE & CO.,
Moline, Ill., November 20, 1888.

DEAR SIR: Your communication of September 13 was received during my absence from home, and was through mistake filed, my attention having never been called to its existence until yesterday.

The river and harbor act of August 11, 1888, can not, in my opinion, mean anything different, or mean any other location except the one mentioned in the memorial of July 25, 1887.

The memorial presented to the Secretary of War by Mr. Gest contains, or did contain at that date (July, 1887), all the facts and information that could reasonably be obtained that would have any bearing on the question.

Of course more reasons are coming forward every day why our city should have a water outlet and inlet for its rapidly increasing traffic, if such can be had without an unreasonable cost, which cost could be determined by survey; and, if I am not mistaken, a copy of such a survey, made by competent engineers, is now in your possession.

Moline is a river town, and, as the memorial states, we had a good landing up to the year 1868, when it was taken from us by the United States Government, leaving us entirely without shipping facilities by water.

The proposed work is both local and general. It can not but be both. It is local in this way, that it gives the people of this locality increased shipping facilities; it is general in that it gives other river towns access to us in a way that they are now deprived of.

Yours, truly,

C. O. NASON,
Mayor City of Moline.

Maj. A. MACKENZIE,
Rock Island, Ill.

The points presented in the petition of the citizens of Moline, which, as is shown by the above letter, are the points to be considered in connection with an examination of Moline City Harbor, are that Moline is an important manufacturing city, making large shipments by rail and furnishing the Chicago, Rock Island and Pacific Railway more freight than any other point on its line west of Chicago; that previous to 1868 Moline had a good landing on the north side of Benham's Island (a small island north of and connected with Rock Island), from which landing large shipments of freight were made at all stages of the river, but that the use of such landing and the former highway leading to it has been prohibited by the Government since it purchased the island, and that the only present method of shipping by water, except at high stages, is by hauling freight to the Rock Island City landing, 3½ miles distant; that a considerable portion of trade of the county naturally tributary to Moline is diverted to more distant points having good landings; that it is of vital importance to the community to have water communication, and that the importance of Moline as a manufacturing and shipping point entitles it to a landing on the Mississippi, if the same can be had at a reasonable expense. The petition further claims that

an excavation made by the commanding officer of the arsenal in connection with the water-power pool furnishes a channel from the head of the wing-dam at the head of the island along the south side of the dam and island to the bridge at Moline; that a slight widening of this channel and the removal of a sand-bar and, probably, a little rock cutting will bring the channel to the public landing at Moline and permit the largest class of steamers to enter the harbor and land at all stages of water; that the commanding officer of the arsenal has presented plans for widening the channel from about 120 feet to 400 feet, and that such widening would bring the channel so much nearer the locality set apart for a public landing.

The facts in this matter as shown by surveys made by the commanding officer of the Rock Island Arsenal, by the citizens of Moline, and by this office, and as shown by official records and personal investigation, are as follows:

Moline is a very important manufacturing city and shipping point. At the present time nearly all of the shipments and receipts are by rail. What proportion of such shipments and receipts would be affected by water transportation, if a safe and convenient landing were available, it is impossible to determine; but enlarging the facilities for water shipments would undoubtedly benefit the manufacturers of Moline and the city generally, by increasing the effect of water competition on railroad rates.

Moline has no natural convenient harbor, being located on the Rock Island Rapids and separated from the channel of the river by a long and broad stretch of shallow water with rock bottom. In former years use was made of a landing on the north side of Benham's Island, which landing was reached by passing over the old bridge and the head of Rock Island. Since the Government purchased Rock Island and established an arsenal thereon this landing has not been used, and the records show that Moline, with a view to hastening the completion of the new Moline Bridge, pledged itself not to ask for certain privileges, among which was that of using the bridge and roadway over the island for a connection with the old landing. But this landing, which is on a rocky shore in a very swift current, involving a haul now considered prohibitory, while taken advantage of when dependence was necessarily placed on river transportation, and used by boats when freights were large and rates very profitable, is not now considered safe or convenient. The landing is, however, as good at the present time as it ever was, and, if any advantage would result therefrom, the Government could be relieved of the charge of injuring the natural shipping facilities of Moline by granting permission to haul freight over the bridge and head of island, but, were such permission granted, it is almost certain that no advantage would be taken of it.

There now exists a narrow and crooked cut in the rock bottom, made to facilitate the flow of water into the pool of the Moline water power, from the head of the wing-dam above Rock Island down to the bridge at Moline. This cut is about 4,400 feet long, from 120 to 140 feet wide, and said to be 3½ feet deep at low water. Originally an increase of width to 400 feet was contemplated, but the estimated cost of such widening was over $300,000, and the plans were so changed as to only call for a total width of 200 feet. This plan, which, in connection with a further improvement of the water-power privileges, may possibly be carried out at some future time, if Congress will appropriate $100,000, the estimated cost of the work. The plans do not, however, provide for an increase of depth or for straightening.

The proposition of the city of Moline is the use of the existing cut from the head of the wing-dam above the island to the Moline Bridge as a navigable channel at all stages for the largest steam-boats on the Upper Mississippi, and the making of such additional mud and rock excavations as will extend the channel across the water-power pool to the Moline shore, where a public landing is to be established just above the bridge. The cut is shown at A A A, and the proposed landing place at B on accompanying sketch.

The existing cut, owing to insufficient width and depth and sharp turns, is not a practicable channel for steam-boats. Even if widened to 200 feet, as is proposed if Congress provides $100,000 for such work, the cut would still be most unfavorable for navigation and, in my opinion, seldom, if ever, used. Such a channel would furnish no greater depth at low water than is now available at a stage of about 3 feet and over, which stage exists during a large portion of the year; yet, at present, boats do not, at any stage of water, enter the so-called Moline Harbor, the inconveniences and delays due to natural causes and unfortunate location being too great to justify such landing. The very great expense of widening, deepening, and straightening this cut so as to make it a practicable channel at all stages, in my opinion, prohibits its consideration.

To connect the existing cut with the proposed landing place will require much mud and rock excavation and probably cost not less than $60,000. The resulting landing, disregarding the unfavorable approach above referred to, would necessitate the maneuvering of boats across the water-power pool immediately above a fixed bridge, an operation which would make the landing anything but safe and convenient. It is probable also that some trouble would result from deposits in the cut and harbor, and possibly, if in the future large amounts of water are drawn off for water power purposes, the water level in the harbor might be effected.

Even were it admitted that the existing cut is, or at small expense could be made, safe and convenient for purposes of navigation, the expensive rock cutting for extending cut to the Moline shore would hardly appear justifiable or necessary, as at much less expense a more favorable landing for steam-boats could be established at the island end of the Moline bridge or at the end of a pier built out to the cut from the Moline shore. Such plans while referred to are not recommended, it not being considered practicable to use the cut as a navigable channel under any of the conditions of enlargement liable to be carried out.

There are points at the upper end of Moline where a landing might be established by the construction of a pier leading to the deep water of the river. Such a landing would be more convenient than the old landing on Benham's Island, but, involving as it does quite a long haul for some of the manufacturers, it is not considered a desirable plan by the representatives of the city of Moline. Such plan also conflicts with the claimed water privileges of certain mills.

For the reasons given I have confined my examination of Moline City Harbor to the locality set apart by the city for use as a public landing and presented for consideration by the representative citizens and city council as the only one suited to their interests or thought by them to be desirable.

While the desirability of a good and convenient harbor at Moline "if it be practicable to have one at reasonable expense" must be acknowledged, the enormous cost which would attend the construction of a harbor at the locality proposed and the approach thereto "so that

the largest steam craft running on the Upper Mississippi may be able to land at the lowest stages of water," and the other facts presented herewith, lead me to the conclusion that "Moline City Harbor, Illinois," is not worthy of improvement by the General Government.

A sketch showing the locality considered is inclosed.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

A A 8.

PRELIMINARY EXAMINATION OF MISSISSIPPI RIVER, THE MAIN SLOUGH AT HAMILTON, ILLINOIS, TO THE END OF SECURING A GOOD AND SUFFICIENT STEAM-BOAT LANDING AT THAT POINT.

UNITED STATES ENGINEER OFFICE,
ROCK ISLAND, ILL., *November* 27, 1888.

GENERAL: The river and harbor act of August 11, 1888, provides for an examination or survey of "Mississippi River, the main slough at Hamilton, Ill., to the end of securing a good and sufficient landing at that point."

The preliminary examination of above-mentioned locality, assigned to me by letter of the Chief of Engineers, dated September 3, 1888, having been completed, I have the honor to submit the following report thereon:

The work contemplated by those at whose suggestion the examination was ordered by Congress, is the construction of a channel suitable for the interests of navigation, from the main river through a slough to the foot of Broadway, in the town of Hamilton, where it is proposed to establish a public landing place.

It is claimed that Hamilton is one of the best produce markets in Hancock County; that in early days the town enjoyed the privilege of having a steam-boat landing, but that about twenty years ago its landing was filled up; that, as a result of such filling up, the operation of saw-mills has been prevented and the shipping of produce has been made expensive; and in general that the future prosperity of the town depends upon the improvement of the facilities for shipment by river.

The town of Hamilton is located on a slough of the Mississippi River, near the foot of the Des Moines Rapids. It has a population of about 1,200. Its receipts and shipments are shown in the accompanying letters of the Business Men's Association, but what part of such shipments and receipts would be effected by the work desired is not known.

Previous to the construction of the Keokuk and Hamilton Bridge, communication with the Iowa shore was kept up by a ferry-boat, which, at low and ordinary stages of water, was obliged to land on the main river bank, at points designated on the accompanying sketch. Occasionally, at very high stages, this ferry-boat was able to pass through a cut-off below present bridge site and into the slough. I can not secure any definite information as to former steamboat business at Hamilton; but, if such business ever existed, all steamers were, from natural causes, restricted to the use of the same landings and channels as were used by the ferry-boat.

It appears that the main slough at Hamilton is not, and never has

been, a navigable channel of the river or a harbor. At the present time the head of this slough is closed by a high gravel bar, water only reaching the slough in an insignificant stream through a narrow and crooked cut-off; and just below the proposed landing the slough is permanently closed to navigation at any stage by bridges. The natural harbor of Hamilton is, and always has been, on the main river bank in front of the town. At present private property cuts off a free approach to this landing; but such obstruction would appear to be one which it is not the province of the General Government to remove. The construction of an additional harbor in the slough which would be good and sufficient for steam-boats, and generally made use of by them, seems impracticable. The elevation of the rock bottom in main river and slough prohibits, except at very great expense, the construction of a passage from the channel of the river to the landing proposed by the people of Hamilton, which could be used by regular packets at a stage of less than 6 feet or by small steam-boats and flat-boats of lightest draught at a stage of less than 3 feet above low water.

While it is apparent that it is not practical to establish a good and sufficient steam-boat landing in the main slough at Hamilton, Ill., available for general commerce, it is possible that a little sand and mud dredging at the cut-off and in the slough would enable small boats of the lightest draught to reach the proposed landing during a portion of the year, and perhaps local shipping interests would reap some benefit thereby; but this dredging of a shallow channel inland from the river to the town must be considered, in effect, as a partial substitute for a public road from the town to the natural landing on the main river bank, and it does not appear to me that the existing conditions or public necessity justify the undertaking of such work by the General Government.

For the reasons given, I am unable to report that the main slough at Hamilton is "worthy of improvement by the General Government."

A sketch, showing locality, and copies of letters received from Business Men's Association of Hamilton, are sent herewith.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF THE PRESIDENT AND SECRETARY OF THE BUSINESS MEN'S ASSOCIATION OF HAMILTON, ILLINOIS.

DEAR SIR: Yours of recent date, and a letter, under date of September 20, from Major Mackenzie, were handed to us by Mayor Bridges, and for reply to the same would respectfully make the following statement:

1. Hamilton has a population of 1,200 inhabitants.
2. Two railroads, the Toledo, Peoria and Western, and the Wabash.
3. That there is shipped out from here annually—

	Cars.
Stone	200
Hay	550
Grain	75
Fruit	25
Apiary stock	8
General merchandise	15
And that we receive for city and vicinity—	
Coal	500
Lumber	50
General merchandise	125

4. Though, being a river town, we have been deprived of a steam-boat landing, except in high water, for over twenty years, and that with a reasonable amount of work done by the Government we would be enabled to take advantage of the facilities offered by river in shipping hay, grain, fruit, and other produce that we ship south, either by river or rail, and that we have to haul on wagons to Keokuk for shipment, and pay toll to the Keokuk and Hamilton bridge, which is an expense on us that could be avoided should we have a steam-boat landing, which would enable us to ship from six to eight months in the year.

5. That we would like to have the landing located at the foot of Broadway street, and the city owns the ground, being Front street.

6. That we find no opposition among the citizens of the city or vicinity, all believing it to be a public benefit.

7. That the location of our town and the future interest of the river points to the necessity of the improvement.

Very respectfully,

J. W. PENCE,
Secretary Business Association of Hamilton.
M. LEROY,
President.

Mr. M. MEIGS,
U. S. Engineer, Keokuk, Iowa.

REPORTS OF THE RIVER COMMITTEE TO THE BUSINESS MEN'S ASSOCIATION OF HAMILTON.

(1.)

HAMILTON, *April* 10, 1888.

Hamilton is situated on the Illinois side of the Mississippi River, at the foot of the Des Moines Rapids. In the early days of her settlement, about 1852, has enjoyed the natural privilege of being a steam-boat landing until about the year 1865. At that time a large quantity of alluvial land began to fill up her natural port, a natural consequence of the sudden settlement of the country in the vicinity of Hamilton, a country which had been considered for a long time as a swampy, wild prairie, and which has become in a score of years one of the most fertile and one of the most thickly-settled of western Illinois.

The local authorities of the city have at different times made appropriations for the improvement of the landing, but without avail, having not the means to appropriate enough funds to effect the improvement so badly needed.

The lumber trade of the city, once the most prosperous of Hancock County, decreased until her saw-mills had to shut down for want of water to bring logs and lumber into her port, and a large portion of her population had to leave to seek employment elsewhere.

Since the year 1875 the fill has constantly increased, and in season of low river it has caused the water to be stagnant in front of the city, and in the summer months the noxious exhalations thereof is a threatening danger to the health of our population.

Hamilton is one of the best produce markets in Hancock County and a good shipping point. The immense quantity of produce shipped from Hancock County finds a natural market in the Southern States, and a well-developed water-way would be an immense advantage to our town and county, and also a national benefit, and we feel that something ought to be done to remove the present obstructions to navigation, and thus encourage our shippers, and particularly the lumber business, so prosperous in former days; and we are of the opinion that a petition ought to be presented to the Congressman of our district, and urge on him the necessity of the improvement for our welfare and prosperity.

Respectfully submitted.

W. H. LAMONTE,
M. LEROY,
G. D. SAYLLER,
JOHN PENCE,
M. B. LANE,
Committee.

(2.)

HAMILTON, *May* 8, 1888.

GENTLEMEN: At your request we have been in correspondence with several river-men, and herein attach letters from Mr. C. A. Hutchinson and C. Farris, who favor the project; and we also find that in former years Messrs. Mack & Dickinson have had large rafts of lumber landed in Hamilton, and that large-sized boats, such as the *Josephine*, of the Diamond Jo Line, have landed in high water and took large shipments of hay and grain as late as 1885, and that it is the opinion of the river-men who have navigated in that part of the river called the Hamilton Slough that it can be improved at a comparatively small expense and be made navigable in the lowest stage of water, and they also think that it is the best place of landing.

We are of the opinion that, should the mud-bar at the entrance of the slough be removed by dredging and widening the channel, it would let into the slough a fair stage of water, and enable boats to land lumber rafts and take shipments of grain, etc., at any reasonable stage of water.

Respectfully submitted.

W. H. LAMONTE,
M. LEROY,
G. D. SAYLLER,
J. PENCE,
M. B. LANE,
Committee.

A A 9.

PRELIMINARY EXAMINATION OF THE MISSISSIPPI RIVER AT AND NEAR THE HEAD OF BEAVER ISLAND, AT CLINTON, IOWA, TO DETERMINE WHAT IS NECESSARY TO REMOVE THE SAND-BARS THERE FORMED AND FORMING, SO AS TO MAKE NAVIGABLE AND PROTECT THE ENTRANCE TO THE WESTERN CHANNEL AND THE CHANNEL ITSELF THAT RUNS BETWEEN BEAVER ISLAND AND THE IOWA SHORE.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., December 5, 1888.

GENERAL: The river and harbor act approved August 11, 1888, provides for "a survey and examination of the Mississippi River at and near the head of Beaver Island, at Clinton, Iowa, to determine what is necessary to remove the sand-bars there formed and forming so as to make navigable and protect the entrance to the western channel, and the channel itself that runs between Beaver Island and the Iowa shore."

By letter dated Office Chief of Engineers, August 28, 1888, I was charged with a preliminary examination of the locality above mentioned with a view to determining whether it is worthy of improvement by the General Government. Having completed such examination and considered all the information it appears practicable to secure, I have the honor to submit the following report:

To ascertain the character of work contemplated by those at whose request this examination was ordered by Congress I addressed letters to the mayor of Clinton and the several lumber firms interested at that point. Under date of September 24 the mayor wrote to me as follows:

I have been trying, since the receipt of your letter of the 10th instant, to get an engineer to make an examination of the sand-bar between Beaver Island and the Iowa shore, so as to give you more definite information than can be obtained by ordinary observation, but our engineers here are very busy in other matters just now, especially the survey for the wagon-bridge here, and I have not been able to accomplish what I intended. I have learned from C. Lamb & Sons and others that the bar is a serious obstruction to the running of the ferry-boat to the Illinois shore, and to the running of the steam-boats of W. J. Young & Co., and C. Lamb & Sons, and other boats of the river necessarily plying in that locality, and from personal observation I have no doubt but such is the case.

Under date of October 18, I again heard from the mayor to the following effect:

I wrote you in September, in answer to your letter of September 10, with reference to the obstruction of the Mississippi River between Beaver Island and the Iowa shore; since that time the water has been lower and the sand-bar obstruction more serious. There is a public ferry running between Iowa and Illinois, and has been for many years, which necessarily passes over this sand-bar, and is a part of the highway between the States, and is regularly used for that purpose by the public generally in those States, and by persons traveling beyond farther east and west; also a large amount of traffic is carried on between the people of Illinois, for 30 miles or more, and the people of the city of Clinton, in farm products and merchandise, and for several months past the business of the public, especially between Iowa and Illinois at this point, has been hindered, delayed, and obstructed by reason of this sand-bar, and many steamboats running on the river, which necessarily pass this point, have been obstructed in the same way, and such has been the case for several years. The expense of removing or improving this bar, I am informed, will not be very great, and it seems to me that the circumstances warrant its being done.

The facts in this case are as follows:

The Mississippi River, just below Clinton, Iowa, is divided by Beaver Island, the main river and low-water channel lying to the east and Comanche Slough to the west of the island. While some work of improvement may be needed in the near future, there is at present no obstruction to navigation in the main river. Comanche Slough has never been considered a navigable channel of the river, its use in connection with through navigation only being practicable at high stages of the river. The main use of the slough appears to be as a storage-ground for logs and harbor for tow-boats of the Clinton Mill owners. The steam ferry, running to Garden Plains, Ill., lands at the head of the slough. A tracing, submitted herewith, shows the condition of the head of the slough in 1878 and 1888. It appears that in the former year sand-bars and very shoal water existed, but that possibly the channel between the sand-bars and the mainland was a little wider than at present. It also appears that as a result of the sand-bars, which will exist, and shoal water, the ferry-boat at low stages has some difficulty in reaching its landing place, and at extremely low stages the landing place must be changed temporarily.

The only practical method of removing the sand at the head of Comanche Slough is by dredging. Such work might give a good channel for several years, but it can not be considered permanent as, owing to natural causes, the bars will reform in time. The works devised for permanently maintaining channels at other points of the river would hardly be justifiable or permissible here, as their effect might be to injure the main river. Instead of opening a channel through Comanche Slough, it is very possible the slough will have eventually to be closed in accordance with the approved plans for the improvement of through low-water navigation of the Mississippi River.

The ferry to Garden Plains is undoubtedly of considerable interest to the city of Clinton, and possibly its present landing place, considering the present condition of channels, is not a convenient one at low water, but it appears that such landing is not on the main river, but in the head of Comanche Slough, probably 1,000 feet from the low-water channel of the river. A large portion of the city lies on the main river above the mouth of the slough, and a landing on the river might be available for the ferry-boat were it not that all this water front, including public streets, is occupied by saw-mills, private piers, booms, log-rafts, etc., and thus closed to the general public.

From correspondence, interviews, and personal examinations, it appears that the principal interest to be served by the proposed work is

that of a ferry running between Clinton and Garden Plains, and owned by C. Lamb & Sons, who also own the saw-mills on Comanche Slough. The general interests of through navigation of the Upper Mississippi are not interested in the improvement desired.

Giving due consideration to the interest of the ferry company and the city of Clinton in the desired work, it still does not appear that the conditions are such, or the public necessity sufficiently great, to justify the carrying out of the proposed improvement by the General Government.

A sketch showing condition of the head of Comanche Slough in 1878 and 1888, is sent herewith.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX B B.

IMPROVEMENT OF THE MISSISSIPPI RIVER ABOVE THE FALLS OF ST. ANTHONY—IMPROVEMENT OF THE CHIPPEWA AND ST. CROIX RIVERS, WISCONSIN, AND OF MINNESOTA RIVER AND RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA—RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI—IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND DAKOTA.

REPORT OF MAJOR CHARLES J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mississippi River above the Falls of St. Anthony, Minnesota.
2. Reservoirs at headwaters of the Mississippi River.
3. Chippewa River, including Yellow Banks, Wisconsin.
4. St. Croix River, Wisconsin and Minnesota.
5. Minnesota River, Minnesota.
6. Red River of the North, Minnesota and Dakota.
7. Surveys for reservoirs at the sources of the Mississippi, St. Croix, Chippewa, and Wisconsin rivers.
8. Yellowstone River, Montana and Dakota.

EXAMINATION.

9. Ice-harbor at or near Bismarck, Dakota, on the Upper Missouri River.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., July 6, 1889.

SIR: I have the honor to forward herewith reports upon the surveys and works for improvement of rivers and harbors in my charge for the fiscal year ending June 30, 1889.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

B B 1.

IMPROVEMENT OF THE MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY, MINNESOTA.

The present project, under which work has been carried on since and including 1880, is based upon the project for the improvement of 252 miles of the river, from Conradi's Shoals to Grand Rapids, the latter the present head of steam-boat navigation. The estimated cost, $54,127.50, is given in the report of February 8, 1875, upon part of the Mississippi transportation routes to the sea-board; plan of improvement to afford

3 to 5 feet depth in the channel by removing snags, bowlders, and bars, and confining the low-water discharge to widths practicable for navigation by means of wing-dams where necessary.

This same report estimated the cost of improvement of the river between the Falls of St. Anthony and St. Cloud at $144,667.50; the improvement of this section to afford 5 feet depth in the channel at low water between the falls and St. Cloud by removal of sand, gravel, and bowlder bars and the construction of wing-dams. The sum of $20,000, appropriated by act of Congress approved August 14, 1876, was expended between those places. Prior to the rendition of the report and estimate of February 8, 1875, Congress had appropriated, by act approved June 23, 1874, the sum of $25,000 for improvement of the river above the Falls of St. Anthony, which was also expended in improving the channel between the falls and St. Cloud.

Steam-boat navigation having discontinued between the falls and St. Cloud, a distance of 78 miles, the third appropriation made by Congress, that of $15,000, by act approved June 14, 1880, was applied to the stretch (165 miles in length) of river between Aitken and Grand Rapids (this stretch included within the distance from the rapids to Conradi's Shoals), as have been all subsequent appropriations for improving the river above the Falls of St. Anthony.

The work during the past fiscal year has consisted in removal of snags, logs, overhanging trees, and bowlders between Aitken and Grand Rapids, under contract for the same with Winston Bros. The contractors commenced work March 11 at Grand Rapids, and by the 18th of May had moved over 75 miles of the river to Pine Rapids, when, the stage of water being too high to admit of removing bowlders, work was suspended until the water should lower, or until warmer weather should admit of the men working in the water. The contractors resumed operations June 19, and completed their contract June 27 by removing bowlders from Pine, Crooked, and Island rapids, the latter 145 miles below Grand Rapids.

Removed from the channels and bends during the fiscal year:

Overhanging trees	number..	8,318
Snags	do....	1,056
Logs	do....	468
Bowlders	cubic yards..	60.4

This work was well done under the inspection of Mr. W. A. Truesdell.

Amount expended on the present project to June 30, 1889, including outstanding liabilities, $53,668.17.

Before work of improvement commenced under the present plan the stream between Aitken and Grand Rapids was so obstructed by snags, bowlders, and leaning trees that at low and even high stages of water navigation was difficult and sometimes almost impossible for steamers drawing less than 3 feet of water. There is now a general depth in the improved channels of 3 feet at low water, though several masses of gravel and a number of bowlders, snags, and leaning trees yet remain to be removed in order to afford sufficient width. Snags form more or less every season, and caving bends furnish leaning trees or sweepers. The movement of ice in the spring also causes deposit, more or less, of bowlders in the channels.

The heavy flood of 1888, by attacking the banks, produced numbers of snags and overhanging trees.

Caving of the banks in many places is also due to the powerful wheel of the steamer *Andy Gibson*, which carries passengers, freight, and

supplies for the lumbermen's camps and settlements, the steamer being too long over all for the narrow widths and sharp bends which occur on this part of the stream.

The three completed reservoirs at the headwaters of the Mississippi River, above Grand Rapids, may be relied upon henceforth to provide sufficient water and depth for the steam-boats on the river at and above Aitken, but the obstructions, as bowlders, etc., should be removed, as they contract the channel and interfere with the movements of steamers at any stage of water.

The estimate of cost of this improvement from Conradi's Shoals to Grand Rapids was made in 1874. The first appropriation applied to this part of the river was that of 1880. The appropriations of 1880, 1881, and 1882, expended between Aitken and Grand Rapids, aggregated $35,000. No appropriation was made after that of 1882 until August, 1888. Between 1884 and 1888 a great many snags, overhanging trees, etc., formed.

Not less than $18,000 will be required to complete the removal of obstructions to navigation between Grand Rapids and Aitken, and that sum can be profitably expended on that work during the fiscal year ending June 30, 1891. This estimate adds $8,872.50 to the original estimate rendered in 1875.

There are at present two steamers with barges engaged in freight and passenger transportation between Aitken and Grand Rapids. There were three steamers, but one of them was burned last winter. It is reported that a new one is to replace it this season. The comparative tables of commercial statistics herewith show that in 1880, the year in which the work of improvement between Aitken and Grand Rapids commenced, there was but one steamer (with its barges) plying between those points, and that though the amount of freight transported that year by steamer was unusually large, the freight rates were from 75 cents to $1 per 100 pounds; while in 1883, 1884, 1885, and 1886 the rates reduced to 20 to 40 cents per 100 pounds. The last-named figures obtained in 1886, at which time there were three steam-boats engaged in freighting and carrying passengers between Aitken and Grand Rapids. The country bordering the river north of Aitken is becoming more and more settled, and there is no doubt that the improvement of the river already effected by the United States Government has largely contributed to the increase in settlement.

Reference is respectfully made to the comparative tables of shipments and rates of freight herewith.

This work is in the collection district of Minnesota, in which St. Paul is the port of entry and St. Vincent a subport of entry and delivery. The total revenues collected on imports in the district for the calendar year ending December 31, 1888, was $206,248.96. Value of domestic exports passing out through and from the district, $976,139.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING THE MISSISSIPPI RIVER ABOVE THE FALLS OF ST. ANTHONY, MINNESOTA.

By act approved—	
June 23, 1874	*$25,000
August 14, 1876	*20,000
June 14, 1880	15,000
March 3, 1881	10,000
By act passed August 2, 1882	10,000
By act of August 11, 1888	10,000
Total	90,000

* Made and expended before the adoption of the present project.

Money statement.

July 1, 1888, amount available, including that for outstanding liabilities ($3.67)		$3.67
Amount appropriated by act of August 11, 1888		10,000.00
		10,003.67
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$7,610.31	
July 1, 1889, outstanding liabilities	1,057.86	
		8,668.17
July 1, 1889, balance available		1,335.50
Amount (estimated) required for completion of existing project		18,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		18,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals opened February 7, 1889, by Maj. Charles J. Allen, Corps of Engineers, St. Paul, Minn.

	No. 1.—Winston Bros., Minneapolis, Minn.		No. 2.—Sidney J. Truax, Hastings, Minn.		No. 3.—Samuel McDonald, Casselton, Dak.	
	Price.	Amount.	Price.	Amount.	Price.	Amount.
For removing overhanging trees:						
4,660, diameter 4 to 6 inches	$0.07	$326.00	$0.30	$1,398.00	$0.25	$1,165.00
3,904, diameter 6 to 10 inches	.25	976.00	.60	2,342.40	.30	1,171.20
2,444, diameter 10 to 14 inches	.40	977.60	1.25	3,055.00	.50	1,222.00
1,142, diameter 14 to 18 inches	.40	456.80	2.00	2,284.00	.50	571.00
376, diameter 18 to 22 inches	.40	150.40	3.00	1,128.00	.75	282.00
210, diameter 22 to 26 inches	.40	84.00	4.00	840.00	1.00	210.00
40, diameter 26 to 30 inches	1.00	40.00	5.00	200.00	1.50	60.00
36, diameter 30 to 34 inches	1.50	54.00	7.00	252.00	1.50	54.00
2, diameter 34 to 38 inches	1.50	3.00	8.00	16.00	3.00	6.00
1, diameter 38 to 42 inches	1.50	1.50	9.00	9.00	3.00	3.00
For removing snags:						
484, diameter 4 to 6 inches	.25	121.00	1.00	484.00	1.50	726.00
294, diameter 6 to 10 inches	4.00	1,176.00	2.00	588.00	2.00	588.00
200, diameter 10 to 14 inches	4.50	900.00	4.00	800.00	2.25	450.00
47, diameter 14 to 18 inches	6.00	282.00	7.00	329.00	2.50	117.50
9, diameter 18 to 22 inches	10.00	90.00	15.00	135.00	3.00	27.00
7, diameter 22 to 26 inches	10.00	70.00	20.00	140.00	3.25	22.75
2, diameter 26 to 30 inches	20.00	40.00	25.00	50.00	3.50	7.00
1, diameter 30 to 34 inches	20.00	20.00	35.00	35.00	4.00	4.00
1, diameter 34 to 38 inches	20.00	20.00	37.00	37.00	4.00	4.00
1, diameter 38 to 42 inches	20.00	20.00	45.00	45.00	4.00	4.00
For removing logs, 500	.45	225.00	3.00	1,500.00	2.00	1,000.00
For removing bowlders, 100 cubic yards.	*2.00	200.00	*30.00	3,000.00	*10.00	1,000.00
Aggregate		†6,233.50		18,667.40		9,194.45

*$2 per cubic yard. †Lowest bid, aggregate, $6,233.50.

COMMERCIAL STATISTICS.

Comparative statement of the steam-boat business on the Mississippi River, between Aitken and Grand Rapids, of the logs run, and of the lumber, shingles, and lath manufactured on the river above the Falls of St. Anthony, for a period of nine years, 1880–1888, inclusive.

Year.	Steamboats.	Freight carried.	Passengers carried.	Logs run.	Manufactured—		
					Lumber.	Shingles.	Lath.
	No.	*Pounds.*	*No.*	*Feet, B. M.*	*Feet, B. M.*	*No.*	*No.*
1880*	1	7, 874, 250	1, 000	226, 000, 000	241, 157, 989	88, 446, 125	49, 423, 100
1881	1	2, 200, 000	1, 540	238, 000, 000	339, 162, 197	128, 532, 050	70, 380, 750
1882	2	3, 028, 000	1, 764	285, 000, 000	423, 009, 250	168, 844, 000	77, 898, 000
1883	2	2, 800, 000	1, 100	420, 000, 000	398, 178, 995	132, 202, 450	83, 193, 825
1884	2	16, 000, 000	1, 346	367, 000, 000	389, 178, 995	123, 487, 300	101, 087, 369
1885	2	5, 000, 000	2, 400	317, 993, 000	340, 020, 000	122, 534, 000	88, 102, 000
1886	3	3, 000, 000	3, 500	282, 600, 000	282, 248, 700	103, 928, 000	58, 959, 000
1887	3	3, 710, 400	2, 884	‡265, 000, 000	272, 044, 907	99, 571, 050	Unknown.
1888†	3	5, 321, 443	2, 860	‡265, 000, 000	§93, 401, 927	§47, 112, 000	§20, 087, 300

*Amount of commerce and navigation when work of improvement began.
†Amount of commerce and navigation at present time, 1888.
‡Approximate.
§Exclusive of that manufactured at Minneapolis.

B B 2.

RESERVOIRS AT HEADWATERS OF MISSISSIPPI RIVER.

The object of the reservoirs is to collect surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the dams. Reduction of heights of floods in localities immediately below the dams expected to obtain to some extent, but control of extended floods or freshets not expected.

The reservoir project is the outcome of surveys and examinations in 1869, 1874, 1878, and 1879, the results of which are published in appendixes to various Annual Reports of the Chief of Engineers.

The résumé of the subject is given in the report of the Board of Engineers printed in Appendix A A to the Annual Report of the Chief of Engineers for 1887.

From the results of the surveys and examinations just noted, and further examinations in 1880, the first cost of constructing 41 reservoir dams in Minnesota and Wisconsin was placed at $1,809,083, exclusive of that of land damages, which could not be given in advance. (See page 1871, Appendix W to Report of the Chief of Engineers for 1881.)

The project for this improvement was inaugurated in 1880 by an appropriation for the construction of a reservoir dam at Lake Winnebagoshish, made by act of Congress approved June 14, that year. For the reasons given in the annual report for 1886, the work of construction commenced and has been continued in Minnesota.

Four reservoirs have been completed; the last, on Pine River at the outlet of Cross Lake, having been completed in 1886, though the greater part of the main dam was finished in 1885.

Congress, by act approved August 5, 1886, appropriated as follows:

For continuing operations upon the reservoirs at the headwaters of the Mississippi River, $37,500; *Provided*, That, in the opinion of the Chief of Engineers, the expenditure of this appropriation and the ultimate completion of this part of the reservoir system will adequately improve navigation.

The subject was referred to the Board of Engineers mentioned above. The Board recommended the raising of the Pokegama Reservoir Dam 2 feet; the building a dam in the Sandy Lake District, if elaborate surveys should prove such to be feasible; the necessary legislation to provide for operating dams, and gaugings of volume of discharge at or near St. Paul during the annual operations of the reservoirs.

A partial survey of Sandy Lake and River was made in 1887. The final examination which was to have been made in the following summer, was necessarily delayed until late in the season of 1888 on account of the country bordering that lake having been subjected to heavy floods.

The work for increasing the lift in the Pokegama Reservoir Dam commenced in August and was practically completed in the June following. The work consists of a dike about 150 feet long, with solid core, and slopes sodded and riprapped.

Some small repairs were made to the log-sluice of the Pine River Dam where running logs had worn it, and some small repairs were also made to the Leech Lake Dam, and a small extension to the Winnebagoshish Dam was also begun.

The work was done by hired labor and purchase of materials in open market.

The accumulated reservoir water was released during the low-water season of 1888 with good effect and to the benefit of steam-boat navigation on more than 200 miles of river, viz: Between Grand Rapids and Aitken, 165 miles, and from St. Paul to some distance below the confluence of the Mississippi and St. Croix rivers. The benefit of the reservoir's volume was experienced generally upon 450 miles length of river. The increase in channel depth at St. Paul, due to the reservoir water, undoubtedly averaged 1 foot during the low-water season of 1888.

During the past spring, and to the close of June, the reservoirs have maintained a boating stage upon the Mississippi between Grand Rapids and Aitken, the river between those points having received but little rainfall.

There are four completed reservoirs, viz:

At Lake Winnebagoshish, completed in 1883–'84.
At Leech Lake, completed in 1884.
At Pokegama Falls, completed in 1884.
At Pine River, completed in 1886.

These dams and their appurtenances must be guarded and maintained. The annual cost of guarding and maintenance is placed at $12,000.

The cost of a reservoir at Sandy Lake, including land damages, is estimated at $52,524.42. This estimate is for dams to raise the level of the lake 7 feet and with provision to admit of passing steamers by lockage from the Mississippi to the lake and return. Steamers occasionally enter the lake, and it is presumed that they should not be barred out.

The three reservoirs above Grand Rapids should be connected by telephone. The cost of this very necessary connection, requiring about 80 miles of wire, is placed at $5,000, and the lowest of these three, that at Pokegama Falls, should be connected by telegraph with Aitken, that being the telegraph station nearest to Pokegama. About 75 miles of telegraph line will be required, at a probable average cost, including that of clearing out the timber to a sufficient distance from each side of the line, of $100 per mile, or for 75 miles, $7,500. The cost of operating and maintaining the line can not be definitely stated in advance, but it will probably not be far from $2,500 per annum.

The balance of funds available July 1, 1889, will be applied to care

of the completed reservoirs, to making some extensions and repairs to the Winnibigoshish Dam, and to general contingencies, and probably to condemnation of lands between Pokegama Falls and Blackberry Brook.

Total expended upon this improvement, including examinations at proposed dam-sites, hydrological observations, land damages, amounts set aside as awards to Indians, and care and maintenance of the works, to the close of the fiscal year ending June 30, 1889, $611,473.53, of which $14,673.26 were expended during the fiscal year ending June 30, 1889.

There can be profitably expended during the fiscal year ending June 30, 1891, the sum of $79,524.42 in care and maintenance of the completed dams and dikes, in creating a reservoir at Sandy Lake, in connecting the upper reservoir by telephone in connecting the Pokegama Falls reservoir and Aitken by telegraph, and in operating and maintaining the line.

For commerce benefited by the reservoirs reference must be made to the commercial statistics of the Mississippi River.

For valuable assistance in work upon, and management of, the reservoirs, I am greatly indebted to Mr. Archibald Johnson, assistant engineer.

ABSTRACT OF APPROPRIATIONS.

By act approved June 14, 1880	$75,000.00
By act approved March 3, 1881	150,000.00
By act passed August 2, 1882	300,000.00
By act approved July 5, 1884	60,000.00
By act approved August 5, 1886	37,500.00
By act of August 11, 1888	12,000.00
Total	634,500.00
Allotment per letter from office Chief of Engineers, November 9, 1881	1,572.15
Allotment per letter from office Chief of Engineers, January 20, 1882	176.00
Allotment per letter from office Chief of Engineers, May 11, 1888	8.60
Allotment per letter from office Chief of Engineers, January 18, 1888	643.85
Awards to Indians for damages in connection with the building of Leech Lake and Lake Winnibigoshish dams, letter from office of Chief of Engineers, August 7, 1885	15,996.90
Allotted and expended by officer in charge for meteorological observations, borings, examinations, etc., at proposed dam-sites, letter from office Chief of Engineers, May 27, 1881	7,500.00
Expended by officer in charge in connection with the building and operating of four reservoir dams to June 30, 1889, including outstanding liabilities	585,576.03
Total allotted and expended to June 30, 1888, including outstanding liabilities	611,473.53
Estimated cost of the system (omitting that of land, etc., damages)	1,809,083.50
Amounts appropriated	634,500.00
Remaining to be appropriated	1,174,583.50

Money statement.

July 1, 1888, amount available		$25,699.73
Amount appropriated by act of August 11, 1888		12,000.00
		37,699.73
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$12,318.35	
July 1, 1889, outstanding liabilities	2,354.91	
		14,673.26
July 1, 1889, balance available		23,026.47

Amount (estimated) required for completion of existing project	$1,174,583.50
Amount that can be profitably expended in fiscal year ending June 30, 1891	79,254.42

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

BB 3.

IMPROVEMENT OF CHIPPEWA RIVER, INCLUDING YELLOW BANKS, WISCONSIN.

The plan for improvement of the Chippewa River consists in revetment of caving bends and construction of dams and jetties, from Eau Claire to the confluence of the stream with the Mississippi River, a distance of 57 miles, to confine the low-water volume to a channel of nearly uniform width and depth. The general plan for improvement was adopted in 1877, and the work has been carried on in accordance with it, varying, however, more or less, as to location and extent of dams, jetties, etc.

The object of protection of the Yellow Banks is to prevent erosion of the high sand-bluffs or banks bordering the Chippewa River at a number of points below Eau Claire, and to thereby relieve the channels of that river and of the Mississippi below the junction of the two streams from the masses of sand contributed by those banks. The plan for protection consists in a revetment of piling and fascines, the latter to be crowned with rock.

The examination of the river upon which the plan and estimate were based was made in 1874. The report, dated January 30, 1875, of this examination, is printed in Part I, Appendix to the Annual Report of the Chief of Engineers, pages 375–380. In that report the estimate of cost of improvement, including protecting the Yellow Banks, was $139,92.50.

The first appropriation for improving the Chippewa River was made in 1876, and the first for protection of the Yellow Banks was made in 1882. These were regarded as separate and distinct works until the act of Congress of August 11, 1888, appropriated for the improvement of the Chippewa River, including Yellow Banks in said river, Wisconsin, continuing improvement, $10,000.

The estimate for channel improvement of the river, as revised in 1887 (see Appendix AA to the Annual Report of the Chief of Engineers for the year ending June 30, 1887), showed that $55,522.96 would be required for completing the work, and that was presented in that report as a new estimate, bringing the cost of the improvement, including all expenditures since the year 1876, up to $172,272.96. This estimate was finally revised in 1888 (see pages 1543–1544 of Appendix Z to the Annual Report for 1888), making it $176,487.72.

The cost of protecting the Yellow Banks, as revised (see Appendix X to the Annual Report of the Chief of Engineers for 1883), was placed at $96,000.

There have been appropriated for the Chippewa River improvement, in all, including that by the act of August 11, 1888, $126,750; and for the Yellow Banks, $30,000.

If we consider these works separately, the cost of completion is as follows:

Chippewa River (channel improvement)	$49,737.72
Yellow Banks	66,000.00

Considering them together, in accordance with the terms of the act of August 11, 1888, the cost of completing the improvement of the Chip-

pewa River, Wisconsin, including protection of the Yellow Banks, is $109,737.72.

The work for improvement during the past fiscal year has consisted in construction of a long wing-dam at Plum Island Flats, and in extensions of and repairs to existing works, as follows:

Table of work performed.

Locality.	Nature of work.	Length of new work.	Length of work repaired or rebuilt.	Materials used.	
				Stone.	Brush.
		Feet.	*Feet.*	*Cu. yds.*	*Cords.*
Battle Island Dam	Repaired west-shore connection and protected head of Battle Island.	100	97	77	116
Wacouta Island Dam	Rebuilt west-shore connection and extended dam.	96	34	200.3	101
Dark Slough Dam No. 2	New work	319		201.5	34
Dam No. 1, Plum Island Flats.	do	1,305		1,545.5	864
Plum Island Dam	Extended dam and rebuilt east-shore connection.	60	100	126.8	48
Five Mile Bluff Dam	Dam leveled off		300	149.3	5
West jetty	Repaired		90	43.8	
East jetty	do		90	92.4	46
Flower Pot Island Dam	do		25	35.5	16
Waubeek Yellow Bank	do		254	554.7	84
Total		1,880	990	3,026.8	1,314

The work was performed by hired labor and purchase of materials in open market as being most economical and advantageous to the Government.

The average cost of brush fascines in the work was $2.65 per cord, and of stone, $1.32 per cubic yard. The lowest prices ever paid for contract work on this improvement were—

For brush in place in the work, $2.99 per cord.

For stone in place in the work, $1.47 per cubic yard.

The showing for the year is a saving of 34 cents per cord of brush and of 15 cents per cubic yard of rock by performing the work by hired labor.

Number of linear feet of dams, revetments, and protection constructed and kept in repair, 1877 (when work was begun) to 1889.

Description.	Locality.	Linear feet.
East jetty, 2,110 linear feet	Mouth of river	*6,219
West jetty, 4,013 linear feet	do	
Shore revetments	do	654
Dam, including shore protection connections	Little Missouri Chute	383
Dams, including shore protection connections	Flower Pot Bar	2,470
Shore protection	Three Mile Prairie	1,335
Two dams, including shore protection connections	Dark Slough	672
Dam, including shore protection connections	Wacouta Island	641
Do	Battle Island	1,282
Do	Jack Staff Island	410
Do	Plum Island	585
Do	Dead Lake Cut-off	475
Jetties, including shore protection connections	Durand	1,200
Dam, including shore protection connections	Eau Claire	810
Upper dam, including shore protection connections	Five Mile Bluff	925
Lower dam, shore protection only completed	do	75
Dam, shore protection only completed	Twin Islands	75
Dam No. 1	Plum Island Flats	1,305
Protection	Waubeek Yellow Bank	2,939
Do	Rumsey's Yellow Bank	‖4,500
Do	Mary Dean Yellow Bank	‡625

*96 feet of this is shore connection.
†1,850 feet completed; piles driven for 2,650 feet, but no brush or stone placed between them.
‡139 feet completed; piles driven for 486 feet, but no brush or stone placed between them.

The system of wing-dams projected for Plum Island Flats must be completed, and improvements are required at other places, as follows:

Locality.	Nature of improvement.	Linear feet, approximately.
Between the jetties at the mouth of the river and upper end of Flower Pot Bar.	Shore protection	2,000
	Dam	2,500
At Five Mile Bluff Bar	Dam and shore protection	1,600
Bar at Ella, between Plum Island and foot of Dead Lake Cut-off Dam.	Dams	300
Eau Galle bars	do	1,200
Bear Creek bars	do	1,000
Dark Slough	do	150
Yellow Banks	Protection	18,000

Expended during the fiscal year, including outstanding liabilities, $8,622.21.

Total expended from commencement of operations in 1877 to June 30, 1889, including outstanding liabilities, $154,334.93. This includes labor, materials, necessary examinations, repairs, superintendence, and contingencies.

Wherever works have been constructed by the Government for the improvement of the river the navigation has been benefited, a low-water depth of 3 to 4 feet being maintained, where, before the works were undertaken, the depth seldom exceeded 18 inches. The work for improvement has been principally confined to the extent of river between the mouth and Durand, 16½ miles, and to the vicinity of Eau Claire.

The jetties at the mouth of the river have been of incalculable benefit to raft and steam-boat navigation in securing a stable channel of sufficient depth where, before improvement commenced, there was a broad bar intersected by shallow, shifting channels, passable with great difficulty at times of low water by rafts and steamers.

The injurious effect upon the channel from the operation of private sluicing dams on the river and its tributaries has been noticed in preceding reports.

Since the branch of the Chicago, Milwaukee and St. Paul Railway was built, in 1882, from Wabasha, on the Mississippi River, to Eau Claire, the branch being close to and generally parallel with the Chippewa, the freight and passenger traffic of the latter has declined. The rafting of manufactured lumber, lath, shingles, and pickets varies in different years, the rafts moving down the Chippewa and between the jetties into the Mississippi. In 1881 the lumber rafted was reported as 342,887,000 feet, B. M.; in 1885, 374,138,443 feet; in 1886, 207,205,672 feet; in 1887, 186,826,521 feet, and in 1888, 161,309,512 feet. The sawlogs, from 300,000,000 to 600,000,000 feet, B. M., which are annually run down the Chippewa, are made up into rafts at Beef and West Newton sloughs for points on the Mississippi River.

The reduction in the cost of running lumber from Eau Claire to the Mississippi River, due to the improvement of the river by the United States, can be arrived at by comparing the contract rates paid by the Daniel Shaw Lumber Company. In 1877, the year when the improvement was commenced, they paid 53½ cents per thousand feet, B. M.; in 1886 and 1887 they contracted for 37 cents.

The sum of $60,000 can be profitably expended during the fiscal year ending June 30, 1891, in constructing and completing dams and revet-

ments between the Dells at Eau Claire and the mouth of the river and in protecting the Yellow Banks.

The small balance of funds, $2,415.07, remaining at the close of the past fiscal year will be applied to care and protection of the existing works.

Mr. A. O. Powell, assistant engineer, has rendered valuable service in connection with the improvement of this river.

This work is in the collection district of Milwaukee, Wis. The duties on imports collected for the year ending December 31, 1888, amounted to $291,492.63.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING CHIPPEWA RIVER, INCLUDING YELLOW BANKS, WISCONSIN.

By act approved—	
August 14, 1876	$10,000
June 8, 1878	10,000
March 3, 1879	8,000
June 14, 1880	10,000
March 3, 1881	10,000
By act passed August 2, 1882	65,000
By act approved July 5, 1884	15,000
By act approved August 5, 1886	18,750
By act of August 11, 1888	10,000
Total	156,750

Money statement.

July 1, 1888, amount available		$1,037.28
Amount appropriated by act of August 11, 1888		10,000.00
		11,037.28
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	8,377.21	
July 1, 1889, outstanding liabilities	245.00	
		8,622.21
July 1, 1889, balance available		2,415.07
Amount (estimated) required for completion of existing project		115,737.72
Amount that can be profitably expended in fiscal year ending June 30, 1891		60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS

The following shows the commerce of the Chippewa River, Wisconsin, in 1877, being the year following the first appropriation (August 14, 1876) for work of improvement:

Lumber	feet, B. M..	160,000,000
Lath and pickets	number..	30,000,000
Shingles	do....	40,000,000

The number of steam-boats plying on the Chippewa River in 1877, or the amount of business done by them, can not be stated exactly. It is said, however, that the business was about the same as in 1881 and 1882. The latter will be found in the comparative statement following.

PRESENT (1888) COMMERCE OF THE CHIPPEWA RIVER.

Lumber	feet, B. M..	161,309,512
Lath	number..	50,544,370
Shingles	do....	86,342,900
Pickets	do....	1,500,320
Logs (Beef Slough)	feet, B. M..	542,437,000

But one steam-boat plied regularly on the river during the season of 1888. This boat, the *Phil. Scheckel*, ran from the mouth to Dunnville, about half way between the mouth and Eau Claire, to assist the Knapp, Stout & Company's rafts in floating down the river. Her passengers and freight were confined almost entirely to the company's rafting business.

Comparative statement of lumber, logs, etc., for eight years.

Year.	Lumber.	Lath.	Shingles.	Pickets.	Beef Slough logs.
	Feet, B. M.	*Number.*	*Number.*	*Number.*	*Feet, B. M.*
1888	161, 309, 512	50, 544, 370	86, 342, 900	1, 500, 320	542, 437, 000
1887	186, 826, 521	64, 725, 580	130, 516, 200	3, 023, 235	404, 302, 650
1886	207, 205, 672	77, 729, 630	158, 645, 750	1, 934, 340	465, 000, 000
1885	374, 138, 443	95, 992, 900	195, 880, 220	75, 000, 000	600, 000, 000
1884	296, 344, 591	88, 905, 520	160, 133, 000	1, 840, 278	534, 674, 176
1883	269, 094, 203	82, 643, 500	129, 754, 000	1, 497, 948	450, 000, 000
1882	375, 000, 000	66, 000, 000	150, 000, 000	2, 200, 000	350, 000, 000
1881	342, 887, 000	64, 797, 000	121, 437, 000	1, 880, 900	300, 000, 000

Comparative statement of freight and passengers for eight years.

Year.	Steamboats.	Freight carried.	Passengers.	Year.	Steamboats.	Freight carried.	Passengers.
	No.	*Pounds.*	*No.*		*No.*	*Pounds.*	*No.*
1888	1	.....	.....	1884	2	1, 500, 000	5, 500
1887	1	600, 000	1, 400	1883	3	3, 184, 000	4, 000
1886	1	.....	4, 700	1882	3	2, 640, 000	10, 490
1885	1	690, 000	4, 728	1881	3	3, 932, 000	16, 980

B B 4.

IMPROVEMENT OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

The original project for the improvement of this river, adopted in 1878, was based upon the results of a survey made in 1874, when the St. Croix was at a high stage of water and but comparatively few bars, etc., to be seen, contemplated the removal of snags, bowlders, wrecks, leaning trees, and sand-bars between Taylor's Falls and Prescott, and contraction of the low-water channel between Taylor's Falls and Stillwater into one of nearly uniform width by means of brush and stone jetties and dams of the same material to close island chutes and secondary channels. Estimated cost, $21,758.

The present project, adopted in 1880 and modified in 1882, is based upon the results of a low-water survey made in 1879, the resulting estimate of cost (see page 1444, Appendix X, Annual Report, 1883) being $83,450. This provided for removal of obstructions, as did the original plan, excepting that it considered more work for the approaches to the "canal" between Four-Mile Island and the foot of the St. Croix Boom than did the orignal plan.

The first appropriation for the improvement of the St. Croix was $10,000, made by act of Congress approved June 18, 1878.

At that date the channel, above Stillwater especially, was encumbered by sunken cribs, wrecks, snags, and old boom-piers, and the bends by leaning trees. The low-water channel had in many places but 2 feet of depth, and steamers and barges made their way as best they could amongst the obstructions. At times it was impossible for them to get over the shoal places.

Under this appropriation some of the worst obstructions were removed between Taylor's Falls and Stillwater.

Another appropriation of $8,000, by act approved March 3, 1879, was expended in the same manner, and in addition the stream was thoroughly surveyed from Taylor's Falls to Prescott, the results of which were reported January 26, 1880. (See pages 1661, 1667, Appendix U, Annual Report of the Chief of Engineers, 1880.)

Upon the results and maps of this survey is based the present plan of improvement.

The work performed in 1878–'79 lessened the difficulties to navigation within the limits worked over.

Under the appropriation of $10,000, by act approved June 14, 1880, work began under the present project, which consists in the construction of dams and jetties to confine the low-water volume to a practicable channel, and in removal of snags, bowlders, cribs, and other obstructions from the channels between Taylor's Falls and Prescott.

The work during the past fiscal year, following the appropriation of $10,000 by the act of August 11, 1888, consisted in removal of snags and sunken logs and other obstructions from the channels, and of leaning trees from bends of the river, between Taylor's Falls and the mouth of the river; in construction of a timber and pile wing-dam on the right bank at the lower end of Hudson Bar, and in dredging a channel 190 feet wide and 700 feet long at the same point; also, in leveling off, and extending 215 feet, the wing-dam at Catfish Bar.

TOTAL OF WORK DONE DURING THE FISCAL YEAR.

Removed from channels and bends.

Drift piles	number	2
Log jam broken	do	1
Piles	do	8
Logs	do	459
Snags	do	138
Stumps	do	61
Overhanging trees	do	125
Sunken crib	do	1
Bowlders	cubic yards	3
Pier-logs	number	29
Linear feet of wing-dam built at Hudson Bar		500
Linear feet of wing-dam built at Catfish Bar		215
Total linear feet of wing-dams built		715

MATERIALS USED IN THE WORK.

Round piles driven	104
6 by 12 inch sheet-piles driven	501
Feet, B. M., of caps and wale pieces	8,600
Cubic yards of rock	719¼
Cords of brush	178

The work was done by hired labor and purchase of materials, excepting 13,782.65 cubic yards of dredging at Hudson Bar, which was done under agreement, at an average price of 21.6 cents per cubic yard, a price that was very reasonable, considering the fact that the dredging machine had to be towed a long distance to the work.

Total expended during the fiscal year ending June 30, 1889, including outstanding liabilities, $9,734.43.

TOTAL OF WORK DONE UNDER PRESENT PROJECT.

Snags removed	number..	1,171
Leaning trees removed	do....	339
Stumps removed	do....	803
Piles removed	do....	16
Cribs or piers removed	do....	8
Wrecks removed	do....	2
Logs removed	do....	592
Clay and gravel removed above Stillwater	cubic yards..	146
Bowlders removed	do....	72.5
Shore protection and revetment built of brush and stone	linear feet..	4,132
Dams and jetties built of brush and stone	do....	9,388
Training-walls at Hudson, built of piles, timber, brush, and stone	do....	2,965
Dredging at Hudson	cubic yards..	22,476.65
Dredging at Catfish Bar, approximate	do....	14,000
Pier-logs removed	number..	29
Drift-piles removed	do....	2
Log-jam broken	do....	1

Total expended under the present project to June 30, 1889, including outstanding liabilities, $74,096.75.

TOTAL OF WORK DONE UNDER ORIGINAL AND PRESENT PROJECTS.

Snags removed	number..	4,053
Leaning trees removed	do....	6,344
Stumps removed	do....	2,722
Piles removed	do....	32
Cribs or piers removed	do....	44
Wrecks removed	do....	3
Logs removed	do....	660
Clay and gravel removed above Stillwater	cubic yards..	146
Bowlders removed	do....	636.5
Shore protection and revetment built of brush and stone	linear feet..	6,332
Dams and jetties built of brush and stone	do....	9,388
Training-walls at Hudson, built of piles, timber, brush, and stone	do....	2,965
Dredging at Hudson	cubic yards..	22,476.65
Dredging at Catfish Bar, approximate	do....	14,000
Pier-logs removed	number..	29
Drift-piles removed	do....	2
Log-jams broken	do....	1

Total expended under original and present projects, to June 30, 1889, including outstanding liabilities, $92,096.75.

All of the work (dredging in 1880 excepted) has been done by hired labor and purchase of materials.

The result of the work to date is a least depth upon the bars above Stillwater, where improvements have been made, of 3 feet at low water, and below Stillwater of 4 to 5 feet. Generally it may be said of the work that at many points navigation has been rendered permanent where formerly it was uncertain, and that in other places it has been made practicable where before improvement it was impossible. There are some bars yet that require improvement above Stillwater, and some of the existing works need small repairs. The Hudson dams should be extended, and the channels at this point and Catfish Bar should receive additional dredging, and a short dam of brush and stone should be built at the latter place to jut out about 150 feet from shore.

Repairs to works are always necessary, more or less, the cost of the same being in inverse ratio to the sums appropriated from time to time to carry them on, and directly as the length of time covered by the appropriations. Unfinished work is almost always more expensive to keep in shape than is finished work.

The cost of repairing existing works, and of the needed improvement

at bars and crossings from Taylor's Falls to the mouth of the river, including removal of snags, piling, old cribs, wrecks, logs, trees, etc., will not be less than $15,000.

The cost of extending the dams at Hudson Bar, and of constructing wing-dams on the right bank of the channel at that point, a total of 3,000 linear feet, at about $4 per foot, is placed at $12,000. To this should be added 30,000 cubic yards of dredging at the Hudson Bar, at a probable cost of 22 cents per cubic yard, $6,600. The cost of the proposed short dam on the Wisconsin side at Catfish Bar, 150 linear feet, at $4 per foot, will be $600. In all, $34,200 for completing the improvement, and this can be profitably expended on the works named during the fiscal year ending June 30, 1891.

This revision adds $25,250 to the estimate of 1882.

As showing the amount of commerce benefited and to be benefited by the improvement, reference is made to the accompanying statistics of the St. Croix River.

The largest steamers plying the Mississippi River between St. Paul and St. Louis ascend the St. Croix to Stillwater, the head of an immense steam-boat and lumber-rafting business, which is dependent upon these improved channels. Smaller steamers run between Stillwater and Taylor's Falls, carrying passengers, agricultural implements, grain, etc. From forty to sixty raft-boats navigate the stream below Stillwater.

From 150,000,000 to 200,000,000 feet, B. M., of logs are, it is estimated, annually towed down the St. Croix River to points on the Mississippi River, to be converted into lumber, while immense rafts of manufactured lumber are annually towed down the stream and into the Mississippi.

The advantages and benefits to the people of the lower St. Croix Valley, due to the improvements already effected, are evident from the lowering of freight rates, which, it is stated, have been reduced at least 50 per cent. since the improvement of the stream commenced. On wheat alone the saving in freight is said to have been considerable.

Portions of the river-bed between Stillwater and Taylor's Falls are obstructed at times by log-booms, which have been noticed in previous reports.

To Assistant Engineer A. O. Powell and Capt. O. F. Knapp, overseer, I am indebted for valuable services in connection with the work of improvement during the fiscal year.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for year ending December 31, 1888, $206,248.96; domestic exports for same period, $976,139.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

By act approved June 18, 1878	*$10,000
By act approved March 3, 1879	*8,000
By act approved June 14, 1880	10,000
By act approved March 3, 1881	8,000
By act passed August 2, 1882	30,000
By act approved July 5, 1884	9,000
By act approved August 5, 1886	7,500
By act of August 11, 1888	10,000
Total	92,500

*Appropriated before adoption of present project.

Money statement.

July 1, 1888, amount available		$137.68
Amount appropriated by act of August 11, 1888		10,000.00
		10,137.68
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$9,692.11	
July 1, 1889, outstanding liabilities	42.32	
		9,734.43
July 1, 1889, balance available		403.25
Amount (estimated) required for completion of existing project		34,200.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		34,200.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Comparative statement of steam-boats and barges, freight, passengers, towing, rafting, logs, lumber, etc., manufactured on the St. Croix River, Wisconsin and Minnesota, for a period of eleven years, 1878–1888.

STEAM-BOATS AND BARGES.

Year.	In freight and passenger business.		In towing and rafting business.		Year.	In freight and passenger business.		In towing and rafting business.	
	Steamboats.	Barges.	Steamboats.	Barges.		Steamboats.	Barges.	Steamboats.	Barges.
1878*	3	.....	6	.....	1884	3	25	30	.....
1879	3	.....	12	.....	1885	4	33	50	.....
1880	3	.....	29	.....	1886	6	38	49	.....
1881	2	.....	40	.....	1887	3	40	58	.....
1882	3	24	77	.....	1888†	1	3	52	.....
1883	3	25	51	.....					

* Amount of commerce and navigation when work of improvement began.
† Amount of commerce and navigation at present time.

FREIGHT, PASSENGERS, AND LOGS.

Year.	Freight carried, to include merchandise, lumber, wood, etc.	Passengers carried.	Logs towed out of St. Croix River (estimated).	Logs passed through St. Croix Boom.
	Pounds.	*Number.*	*Feet, B. M.*	*Feet, B. M.*
1878*a*	32,000,000	15,000	70,000,000	160,000,000
1879	47,786,995	9,244	117,000,000	202,000,000
1880	(*b*)	(*b*)	200,000,000	207,100,000
1881	*c*35,000,000	11,015	185,000,000	233,000,000
1882	*d*60,000,000	10,300	130,000,000	276,000,000
1883	*e*63,000,000	2,800	108,000,000	270,000,000
1884	*f*80,000,000	4,000	175,000,000	275,000,000
1885	*g*85,000,000	10,647	150,000,000	231,000,000
1886	*h*180,000,000	12,756	115,700,000	193,500,000
1887	*i*57,009,320	9,872	175,000,000	300,000,000
1888*k*	*j*19,108,000	.....	136,000,000	364,803,410

a Amount of commerce and navigation when work of improvement began.
b Estimated same as 1879.
c About 18,000,000 pounds lumber and wood.
d About 48,000,000 pounds lumber and wood.
e About 53,000,000 pounds lumber and wood.
f About 70,000,000 pounds lumber and wood.
g About 73,000,000 pounds lumber and wood.
h About 85,000,000 pounds lumber and wood.
i About 56,000,000 pounds lumber and wood.
j Lumber and wood only.
k Amount of commerce and navigation at present time, 1888. On account of log-jams above Stillwater there was during season of 1888 practically no navigation above that point.

LUMBER, ETC., MANUFACTURED AND RAFTED.

Year.	Manufactured.				Rafted.			
	Lumber.	Shingles.	Laths.	Pickets.	Lumber.	Shingles.	Laths.	Pickets.
	Feet, B. M.	*Number.*	*Number.*	*Number.*	*Feet, B. M.*	*Number.*	*Number.*	*No.*
1879	83,727,820	40,228,000	27,600,000					
1880	132,475,078	54,052,500	37,845,000					
1881	135,000,000	70,000,000	40,000,000	362,000				
1882	116,000,000	62,000,000	32,000,000	209,000,000				
1883	167,000,000	80,000,000	45,000,000	615,000				
1884	125,000,000	25,000,000	25,000,000	615,000				
1885	200,000,000	65,000,000	30,000,000	11,000,000				
1886	75,000,000	1,400,000	600,000					
1887	150,000,000	55,000,000	32,000,000	9,000,000	100,000,000			
1888	170,807,541	70,845,250	42,383,950	575,774	114,610,966	40,079,500	23,651,800	570,820

B B 5.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

An examination of this stream was made by Maj. G. K. Warren, Corps of Engineers, in 1866, under authorization of section 4 of the act of Congress approved June 23, 1866. Major Warren's first or preliminary report of this survey was rendered January 21, 1867, and printed as a part of Senate Ex. Doc. No. 58, Thirty-ninth Congress, second session.

The estimates of cost of improvement, based upon results of this examination and survey, are given in the Report of the Chief of Engineers for the year ending June 30, 1867. Two plans are considered, viz, one to improve the navigation of the river from the Yellow Medicine to the mouth of the Minnesota by means of locks and dams, so as to secure 4 feet of water, at a cost of $775,500, and another to secure 2 to 3 feet of water, by removal of snags and bowlders throughout this stretch of river, in addition to the construction of a lock and dam at Little Falls, and the operation of a scraper and dredge-boat, at a cost of $117,000.

The river and harbor act of Congress approved March 2, 1867, appropriated $37,500 for removing snags and bowlders throughout the Minnesota River, thus sanctioning the second plan.

The river and harbor acts of Congress approved June 11, 1870, and March 3, 1871, each appropriated $10,000 for continuing the improvement.

The second section of the river and harbor act of Congress approved June 10, 1872, provided for the survey of the Minnesota River above the mouth of the Yellow Medicine, which survey was made during the same year, the report pertaining to which is printed in the Report of the Chief of Engineers for the fiscal year ending June 30, 1873. The removal of obstructions, principally bowlders, was recommended.

The same act (approved June 10, 1872) appropriated $10,000 for the improvement of the stream, which sum was expended in the removal of bowlders, overhanging trees, etc.

By act approved March 3, 1873, there was appropriated—

> For the improvement of the Minnesota River, Minnesota, $10,000: *Provided*, That one-half of said sum shall be expended between the mouth of the Yellow Medicine and Minnesota Falls, on said river.

This appropriation was applied to the removal of rocky ledges, bowlders, snags, and overhanging trees. The total of appropriations to March 3, 1873, inclusive, was $77,500.

By act of Congress approved June 23, 1874, an appropriation of $10,000 was made "for the survey or improvement of the Minnesota River." A survey was made from the mouth of the river to South Bend, a distance of 116.4 miles, to determine the practicability of improving the navigation by means of canals, locks, and dams. The results of this survey proved the possibility of lock and dam navigation for the distance passed over, the estimated cost of improvement, as stated in the report of the survey printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1875, being, for five locks and dams and removal of snags, etc., $733,868.63, the cost of removing snags, etc., being therein placed at $34,585.10, including contingencies. Following this report Congress made three appropriations, of $10,000 each, by acts approved March 3, 1875, August 14, 1876, and June 18, 1878, which sums were applied to clearing the river of obstructions below South Bend.

The object of all the work for improvement was to facilitate navigation by steamers. Before any work of improvement was undertaken, the river was almost impassable at low water for boats. The removal of obstructions cleared the way over long stretches of the river between Minnesota Falls and a point about 30 miles below Henderson. Little or no use, however, was made of the improved channels, there being no steam-boat navigation of the river worth reporting. The rapidly-caving banks of that river add snags and leaning trees to the channel yearly, so that channels which were cleared of obstructions ten years ago are more or less encumered with them to-day.

It is claimed by those interested in the Minnesota Valley that, were the improvements extended by the construction of locks and dams, steam-boats and barges would navigate the river and carry much of the freight that now depends upon rail for transportation.

The river and harbor act of Congress approved August 5, 1886, authorized a survey of the Minnesota River with a view to its improvement by locks and dams. The survey, extending from the mouth of the river to Mankato, was made during the season of 1887, and a report thereon, with maps, rendered January 16, 1888. This report, printed in Ex. Doc. No. 158, House of Representatives, Fiftieth Congress, first session, is respectfully referred to as containing the most reliable statistics of the present and prospective commerce of the Minnesota River that could be obtained.

By the river and harbor act of August 11, 1888, Congress appropriated for—

> Improving Minnesota River, Minnesota, including protecting and holding the banks opposite the borough of Belle Plaine, so as to prevent the river from cutting through the narrow neck of land at that point and thereby changing its channel and course, ten thousand dollars.

This is the first appropriation made since 1878, for improvement of the Minnesota River.

An examination of the river at Belle Plaine and also from Carver to the mouth of the stream was made in September, 1888, with a view to obtaining data upon which to base a project for the advantageous expenditure of the sum appropriated by the act of August 11, 1888.

The examination showed that there had not been any marked erosion of the bend at Belle Plaine for several years past; but that to thoroughly protect it against such erosion as might occur from floods or from changes in the channels of the river above the bend would undoubtedly cost more than the entire sum appropriated for the river. It also showed that there had not been any steam-boat navigation of the river

at that point (an occasional trip by a steam-boat at high water excepted) for a number of years.

The cost of an adequate open-channel improvement of the river from its mouth to Carver, such an improvement as might last for a number of years, was found to be not less than $52,000.

The appropriation being inadequate for thorough work at either Belle Plaine or the extent of river from its mouth to Carver, and still less adequate for the performance of work if divided between them, it was recommended that the submitting a project for expenditure of the appropriation be delayed until the further wishes of Congress might be known, or until some definite information as to prospective navigation might be obtained upon which to base a project for the best utilization of the appropriation.

It is reported that during the navigation season of 1888 one small steamer, the *Ida Campbell*, transported between St. Paul and Shakopee, 25.9 miles above the mouth of the Minnesota, 350 tons of hay and 1,500,000 brick, and that there is now one steamer engaged in transporting brick, etc., between the same points.

Total expended under the project following the survey of 1874, $29,985.60.

Total expended under all projects, including the survey, $117,485.60.

Should Congress order an open channel improvement below Carver the sum of $25,000, in addition to that appropriated in 1888, could be expended during the fiscal year ending June 30, 1891.

This work is in the collection district of Minnesota, in which St. Paul is the port of entry and St. Vincent a sub-port of entry and delivery. The total revenues collected on imports in the district for the calendar year ending December 31, 1888, was $206,248.96. Value of domestic exports passing out through and from the district, $976,139.

ABSTRACT OF APPROPRIATIONS MADE FOR THE IMPROVEMENT OF THE MINNESOTA RIVER.

By act approved—	
March 3, 1867	$37,500
July 11, 1870	10,000
March 3, 1871	10,000
June 10, 1872	10,000
March 3, 1873	10,000
June 23, 1874	*10,000
March 3, 1875	10,000
August 14, 1876	10,000
June 18, 1878	10,000
By act of August 11, 1888	10,000
Total	127,500

Money statment.

July 1, 1888, amount available, including that for outstanding liabilities ($9)		†$42.00
Amount appropriated by act of August 11, 1888		10,000.00
		10,042.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$18.60	
July 1, 1889, outstanding liabilities	9.00	
		27.60
July 1, 1889, balance available		10,014.40

* Used in making survey of river.

† Forty-two dollars, balance from former appropriations, deposited to credit of Treasurer of the United States November 11, 1885.

Amount (estimated) required for completion of existing project	$693,868.63
Amount that can be profitably expended in fiscal year ending June 30, 1891	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

There are no statistics to report other than already given.

B B 6.

IMPROVEMENT OF RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

The present, which is also the original, project for the improvement of this river from Breckenridge to the northern boundary line, adopted in 1877 and amended as to estimate of cost in 1883, consists in the removal of snags, leaning trees, and bowlders, and in dredging channels through the bars.

The estimated cost of this improvement, omitting the item of improvement of Goose Rapids, as based upon the reports of 1874, 1875, and 1877 (see pages 730–732, Report of Chief of Engineers, 1878), was $145,310.18, which estimate, as revised, and for the reasons stated in Appendix X 8 of the Annual Report of 1883, was increased to $179,310.18.

The river and harbor act of Congress approved August 5, 1886, making the money theretofore appropriated for locks and dams at Goose Rapids available for dredging, removal of snags and bowlders, and construction of wing-dams, necessarily included in that mode of improvement Goose Rapids, which were originally intended to be improved by means of locks. For this reason, as well as for others given in the Annual Report for 1887, a new estimate of cost of completing the work became necessary. The cost was placed at $79,598.37 (see Appendix A A to the Annual Report of the Chief of Engineers for 1887, pages 1714, 1715).

But one dredge-boat has been operated during the year, the other, built in 1879, requiring renewal of the hull before it can be further used on the work. The dredging, in 1888, was confined to the lower half of Goose Rapids. Upon resumption of work, this year, 1889, the dredge worked on the shoal places below Grand Forks.

The excavated material was utilized, as in former years, in forming training-dams to confine and direct the water at low stages, and also to as far as possible leave the area of cross-section of the stream after excavation what it was before excavation, and also so placed as to reduce, wherever necessary, the velocity of the stream. In general, the work has been so carried on that, while increasing the depths at crossings, the pools above and below the bars have not been lowered. The material, a tough, leathery clay, is not liable to be rapidly washed away, and the best disposition that could be made of it was to use it for dams. To raise the material to the top of the bank through heights of 35 to 45 feet would have been expensive without securing much, if any, advantage, as floods frequently cover the banks and approaches to the river.

SUMMARY OF WORK DONE DURING THE YEAR ENDING JUNE 30, 1889.

Cubic yards of material dredged		40,767
Length of wing and training-dams built	feet	7,798
Length of channel cuts	do	6,625
Total of miles of river worked over		28

The result of the year's work has been improved channels on the lower half of Goose Rapids to afford depth of 3 feet at ordinarily low water, and channels to afford a depth of 4 feet, at the same stage, for 62 miles by river below (north of) Grand Forks.

The total work done upon this stream since the first appropriation for its improvement was made in 1876, and extending from Fort Abercrombie to a point 62 miles by river below Grand Forks, a total river distance of 290 miles, is as follows:

Number of cubic yards of material dredged	501,735
Number of snags removed	618
Number of overhanging trees removed	8,705
Cubic yards of bowlders removed	382
Number of stumps removed	198
Number of piles removed	23
Number of drift-piles removed	8
Barge removed	1
Total linear feet of channel excavated	88,797
Total linear feet of wing and training dams constructed	127,040

Mr. Rufus Davenport, assistant engineer upon this improvement for the past seven seasons, is deserving of great credit for faithfulness and zeal in carrying out the work intrusted to him.

All the work for improvement of this stream has been performed by hired labor.

GENERAL CONDITION OF THE WORK.

The 3-foot dredged channels from Moorhead to a point 80 miles north, averaging 60 feet in width at low water, and the 4-foot dredged channels from Grand Forks to a point 62 miles north (distance by river), averaging 70 feet in width, are in good condition, and no difficulty is experienced over those improved portions of the stream by boats loaded for those depths at ordinarily low stage of water, and 3 feet can be carried over the improved portions of the rapids and of the river between Frog Point and Grand Forks. The removal of snags and trees between Moorhead (opposite Fargo) and Abercrombie improved that portion of the stream for navigation during high and medium stages of water.

The river is subject to land-slides, several of which have occurred within the past four years at Goose Rapids and near Frog Point. These slides can never be anticipated, form obstructions when they occur, and have to be removed in whole or in part, thereby increasing the amount and cost of the improvement.

Generally since the first bars were dredged in 1879 the carrying of grain in barges has been greatly facilitated. Before the dredging commenced in 1879 there were but 1½ feet of water (ruling depth) upon bars between Moorhead and Goose Rapids and 2 feet on the bars below Grand Forks at ordinarily low water, and before the removal of snags and leaning trees between Moorhead and Abercrombie navigation over this portion of the stream was at all times difficult.

Remaining to be done.—Excavation of bars between Breckenridge and Fargo and from a point 10 miles above Goose Rapids to the middle of the latter; a small amount of excavation from the foot of the rapids to

a point 62 miles north of Grand Forks; dredging at the Pelican Bars, 115 miles north of the forks, and removal of overhanging trees, snags, and bowlders at a number of points; also retouching some of the work between Fargo and Goose Rapids.

The comparative statement of freight carried during the calendar years 1879–'88, appended, shows considerable fluctuation, being greatest in 1882 and least in 1887. The decrease for 1886–'88 is attributable largely to the low stage of water and, in addition, in 1888, to failure of the wheat crop.

Although but few steamers navigate the Red River at present, the fact of an improved river being available for an unlimited number of steamers and barges whenever railroad rates become insupportable operates to the advantage of the farming community.

Expended upon this improvement during the fiscal year ending June 30, 1889, including outstanding liabilities, $13,552.56.

Expended upon the improvement from commencement of work in 1877 to June 30, 1889, including outstanding liabilities, $173,765.08.

It is proposed to apply the balance of appropriation remaining in furtherance of the present project of improvement.

The sum of $40,000 can be profitably expended during the fiscal year ending June 30, 1891, in continuing dredging operations and in removal of obstructions generally between Breckenridge and the northern boundary line.

The Red River of the North, from its source to the international boundary line, is wholly within the customs district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for year ending December 31, 1888, $206,248.96; domestic exports for same period, $976,139.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

By act approved—	
August 14, 1876	$10,000.00
June 18, 1878	30,000.00
March 3, 1879	25,000.00
June 14, 1880	20,000.00
March 3, 1881	18,000.00
By act passed August 2, 1882	10,000.00
By act approved July 5, 1884	10,000.00
August 5, 1886	46,947.65
By act of August 11, 1888	20,000.00
Total	189,947.65

Money statement.

July 1, 1888, amount available		$9,735.13
Amount appropriated by act of August 11, 1888		20,000.00
		29,735.13
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$11,679.42	
July 1, 1889, outstanding liabilities	1,873.14	
		13,552.56
July 1, 1889, balance available		16,182.57
Amount (estimated) required for completion of existing project		59,598.37
Amount that can be profitably expended in fiscal year ending June 30, 1891		40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Comparative statement of freight moved by steam-boats on the Red River of the North, Minnesota and Dakota, for ten years, 1879 to 1888.

	Pounds.
1879	35,718,731
1880	43,301,515
1881	53,114,861
1882	63,303,629
1883	50,627,591
1884	58,091,472
1885	46,085,499
1886	21,013,657
1887	20,809,820
1888	24,279,270

B B 7.

SURVEYS FOR RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI, SAINT CROIX, CHIPPEWA, AND WISCONSIN RIVERS.

Nothing was done under this head during the past fiscal year, no funds having been available for such work. For account in detail of these surveys reference is made to pages 1,507 and 1,508, Appendix Y, Part 2, Annual Report of the Chief of Engineers, 1886.

Money statement.

Amount (estimated) required for completion of existing project..... $50,000

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

B B 8.

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND DAKOTA.

The present approved project is to work down the river from Glendive in order to repair existing dams and build new wing-dams and dams to close island chutes where necessary, so as to confine the water generally to one channel, and thus increase the depth on the rapids and shoal places. Also, to remove rocks and bowlders from the channels. (See Appendix X 2 to Annual Report of the Chief of Engineers for 1887.)

The original condition of the navigable channel of the Yellowstone was bad and unsafe, due to the existence of numerous swift rapids, to crooked and shallow channel at low water, and to the presence of rocks and loose bowlders. By removing the latter at the worst places, and by confining the water to one channel, so as to increase the depth on the rapids, the river has been considerably improved for purposes of commerce. Up to July 1, 1886, $99,306.49 had been expended upon the improvement, and at that date the condition of the improved river was much better than at present, as the dams have received no repairs since that date and are broken in many places.

For reasons given in Appendix X 2 to the Annual Report for 1887, by my predecessor in charge, one of them being the inadequacy of the appropriation of 1886 (the last appropriation) to perform sufficient work to justify the cost of extensive repairs and of new outfit, no work for

improvement has been undertaken since 1885, the project having been suspended in order that the whole matter might be reported to Congress.

In the Appendix to the Annual Report for 1887, referred to, it is said:

> The Yellowstone, for a swift, snow-fed river, is an excellent one naturally, and susceptible of radical improvement at a relatively small expense, considering its distance from labor and supply markets. Though not at present navigated, the existence of a good navigable channel will always be a check on high railroad tariffs to competing points on the river.
>
> If Congress deems this a sufficient cause for the continuation of the improvement, $60,000 in addition to the present available balance can be profitably expended during the fiscal year ending June 30, 1889.

So far as learned, there are no boats engaged in navigating this river, and there is no immediate prospect of any being put on it.

The funds that were available when the Annual Report for 1887 was written having been reduced in consequence of necessary repairs to the plant in the latter part of that year, and from subsequent care of the plant and other contingencies, the estimate for the fiscal year ending June 30, 1891, should Congress continue the improvement, is placed at $65,000.

Expended during the year ending June 30, 1889, for care of the plant and for other contingencies, including outstanding liabilities, $1,319.27.

Total expended upon this improvement to June 30, 1889, $106,808.29.

ABSTRACT OF APPROPRIATIONS.

By act approved March 3, 1879	$25,000.00
By act approved June 14, 1880	15,000.00
By act approved March 3, 1881	20,000.00
By act passed August 2, 1882	20,000.00
By act approved July 5, 1884	20,000.00
By act approved August 5, 1886	18,750.00
Total	118,750.00

Money statement.

July 1, 1888, amount available	$13,260.98
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	1,319.27
July 1, 1889, balance available	11,941.71
Amount (estimated) required for completion of existing project	106,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	65,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

B B 9.

PRELIMINARY EXAMINATION FOR ICE-HARBOR AT OR NEAR BISMARCK, DAKOTA, ON THE UPPER MISSOURI RIVER.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., December 17, 1888.

GENERAL: I have the honor to submit the following report of a preliminary examination for "ice-harbor at or near Bismarck, on the Upper Missouri River," made in accordance with the provisions of sections 13 and 14 of the river and harbor act of Congress of August 11, 1888.

On the 27th of October last, accompanied by Mr. A. O. Powell, as-

sistant engineer, I proceeded to Bismarck for the purpose of examining the Missouri River in the vicinity of that place, and also with a view to obtaining, on the ground, facts bearing upon the necessity or feasibility of establishing an ice-harbor, in order to determine whether or not a full survey of the locality, from which to estimate the cost of such harbor, should be recommended.

We reconnoitered the river from the upper end of Rock Haven, on the right bank, about 5 miles above Bismarck, to the lower end of Sibley Island, on the left bank, about 11½ miles below Bismarck, without finding any location offering advantages for either a natural or artificial harbor, Rock Haven excepted, which will be described further on.

The localities named and the river generally, for about 20 miles above and below Bismarck, are shown on the accompanying tracing, which is made up from blue prints kindly furnished me by Lieutenant Bingham, United States Corps of Engineers, secretary of the Missouri River Commission, and who states that the sketches are from reconnaissance only. Sibley Island is on this sketch-map called Assiniboine Island.

Bismarck is on the left bank of the Missouri, and distant by river about as follows:

	Miles.
From Fort Benton	816
From Sioux City	655
From the mouth of the river (confluence with the Mississippi)	1,458
From the principal steam-boat landings at St. Louis	1,480

The city is mostly on high ground or bluffs, bordered by an immense stretch of bottom-lands, which are submerged at floods, and over which masses of ice are moved more or less during the spring "break-ups." The banks—those of the bottom-lands especially—are generally of light, movable material, and subject to heavy scour at high and medium stages of the river.

Rock Haven is bordered by steep banks, rising 15 to 20 feet above low water, and underlaid by rock in place, which renders them comparatively stable. This locality has been used for a number of years past as a winter harbor for steam-boats.

The Northern Pacific Railroad crosses the Missouri at Bismarck, on a high bridge of three spans, two of 403¼ feet each and one of 405 feet in width, measured from centers.

At the time of our examination the river was at a very low stage, the widths at some points not exceeding 550 feet. The sketch-map herewith shows the river at a much higher stage.

The greatest danger to vessels on the Missouri River arises, according to general testimony, from the breaking up of the ice in the spring. At such times the ice moves in great masses, more or less broken up, with sufficient power to carry before it everything of artificial construction in its path, unless built of the heaviest and most solid material. The gorges of ice, which frequently occur where the river narrows or where the channel is obstructed by bars, raise the surface of water in the reaches above them, the ponded-up water not only overflowing bottom-lands, but frequently causing immense masses of ice to traverse them. It is said that ice-gorges not unfrequently raise the water-surface 25 to 30 feet. When such gorges give way suddenly the rush of water and ice is most destructive.

It is the general testimony of such Missouri River men as could be communicated with on the subject that there is no perfectly safe winter harbor on the Upper Missouri River (Sioux City to Fort Benton), but that Rock Haven offers the greatest security of any, though it has only

capacity for sheltering five to eight steam-boats. The reason assigned by Missouri River steam-boat men for the security of Rock Haven as a winter harbor, is that its bank is stable, and that the outline of the river banks at and just above Rock Haven resembles an hour-glass, with the neck at the head of the haven; that ice-gorges form at the neck, and, when they break, the released ice has plenty of room to spread in the wide part below without crowding; moreover, the set of the current during high stages of water (the ice here always goes out on a rise in the river) is toward the left bank, whether after a breaking of a gorge above or whether the ice is running freely; hence boats laid up at Rock Haven are not endangered by crowding ice or by ice moving down stream. It does not appear that moving ice has traversed Rock Haven Prairie in sufficient quantity to endanger boats from that side. But one steam-boat has been sunk at Rock Haven. This vessel—a small ferry-boat, the *Undine*—was lost, as her owner, Capt. W. Braithwaite, informed us, solely through the carelessness of the men in charge of her.

The persons at Bismarck engaged in the navigation of the river, from whom information was principally sought, were Capt. I. P. Baker, general superintendent of the Benton Transportation Company's line of steamers, and Captain Braithwaite. To these must be added Mr. J. J. Moog, a river-mate of experience.

The general views of these gentlemen may be briefly stated as follows:

Captain Baker urged the importance of the establishment by the Government of an ice-harbor, which could be used by steamers of different lines on the river, and also by the Government fleet of boats. It was his opinion that, although but four or five steamers had wintered in the vicinity of Bismarck for several years past, sixteen to twenty steamers would make use of such a harbor. He referred to the fact that owners of steam-boats could not insure against damage from ice break-ups in the Upper Missouri River. He also said that two steamers of his line, laid up in Rock Haven, were, on one occasion, seriously threatened by the movement of ice. It was his opinion that, were a good ice-harbor established, steam-boats from long distances would seek its protection.

Captain Braithwaite, however, emphatically declared that he considered Rock Haven as it was sufficient for a winter harbor for such boats as would seek it for a number of years to come, and that, in fact, he did not regard any artificial harbor in that vicinity as necessary or as practicable.

Mr. Moog's opinion was essentially the same as Captain Braithwaite's.

All agreed that Rock Haven did not afford capacity for the accommodation of more than five or six steam-boats.

Upon my return to St. Paul I addressed letters to Capts. W. H. Gould, of Yankton, Dak., and Joseph Todd, St. Louis, Mo., practical navigators of the Missouri River, asking information as to the necessity of the ice-harbor under discussion, and whether, if there were a safe and capacious harbor at or near Bismarck, steam-boats would leave Omaha, Sioux City, Yankton, or other points on the Missouri in time to reach that harbor for the winter. (See Appendix *a*).

Captain Gould wrote in answer (see Appendix *b*) that he thought Rock Haven the most secure harbor in the vicinity of Bismarck for the wintering of steam-boats, and that it would accommodate six to eight boats; also, that he was of opinion that no boats would go up the river

in quest of winter harbors from that section (Yankton and its vicinity), as they could be pulled out on top of the bank much cheaper than they could be taken so far.

Capt. John Barr, a Missouri River navigator whom I met in St. Paul, appeared to hold the same opinions that Captain Baker held.

I wrote to Captain Baker November 21, and again November 30, requesting him to embody in a letter to myself his views regarding the proposed ice-harbor (see Appendices *c* and *d*), and received in answer a letter dated December 4, which is in substance a reiteration of his views as expressed last October. (See Appendix *e*.) For statistics, he refers me to certain United States Engineer reports.

On page 1362, Part 2, Appendix V to the Annual Report of the Chief of Engineers, 1883, Captain Maguire reports:

In 1881 five lines of steam-boats made their headquarters at Bismarck, Dak., and twenty-one boats plied between that town and points on the Missouri River, making, during the season of navigation, from one hundred and fifty to one hundred and seventy-five trips. These boats carried into Montana 27,560,000 pounds of private and 7,200,000 pounds of Government freight, making a total of 34,760,000 pounds, valued at $5,214,000. In addition, there were transported 1,300 passengers, 2,400 Indians, 1,800 head of horses and cattle, and 600 head of sheep. The exports, as far as learned, were as follows: 23,000 buffalo hides, valued at $37,500; 180 tons wool, valued at $90,000; 253,750 pounds of hides, pelts, etc., valued at about $76,125, and also an unestimated quantity of furs and wolf-skins.

In 1882 the number of steam-boat arrivals at Benton was forty, the number of departures from Bismarck being eighty-six, and the number of arrivals at the same place being eighty-five.

The total shipment of freight from Bismarck was 32,194,041 pounds, of an approximated value of $4,829,106. Of this amount 5,100,000 pounds was Government freight. There were 3,500 passengers and 1,200 troops transported.

On page 1542, Part III, Appendix W to Annual Report, 1884, Captain (now Major) Quinn reports:

During the season of 1883 there was transported upon the river under my charge 23,595,144 pounds of freight and an unknown number of passengers. A large percentage of this freight was Government goods and supplies.

On pages 1601 and 1602, Part 2, Appendix X to the Annual Report, 1887, appear the following as appendixes to the report of Captain Sears:

STATEMENT OF BUSINESS TRANSACTED ON THE MISSOURI RIVER BETWEEN SIOUX CITY, IOWA, AND BISMARCK, DAKOTA, AND BETWEEN FORT BENTON, MONTANA, AND BISMARCK, DAKOTA, 1886.

Above Bismarck.

Trips up, 23:	
General merchandise carried, 5,750 tons	$1,500,000
Trips down, 23:	
Sacks wool (3,800), 1,064,000 pounds	234,080
Hides, peltries, furs, and merchandise, 1,000,000 pounds	50,000
Grain, 600,000 pounds	6,000
Passengers carried	400

Below Bismarck.

Trips, 20:	
General merchandise carried, 5,000 tons	$287,000
Passengers carried	1,500

STATEMENT OF BUSINESS TRANSACTED ON THE MISSOURI RIVER BETWEEN SIOUX CITY, IOWA, AND BISMARCK, DAKOTA, AND BETWEEN FORT BENTON, MONTANA, AND BISMARCK, DAKOTA, TO JULY 1, 1887.

Above Bismarck.

Trips up, 25:	
General merchandise carried, 6,875 tons	$2,300,000
Down-stream:	
Wool, hides, furs, and merchandise 320 tons	
Passengers carried	610

Below Bismarck.

Trips, 10:	
General merchandise, tons carried, 1,600	$144,000
Passengers carried	250

[NOTE.—Much of the up-river tonnage above Bismarck represents railroad material and supplies for the building of the Manitoba Railroad. It is abnormal in quantity and value.—C. B. S.]

It appears, by comparison of the statistics, that the number of arrivals and departures of steam-boats at Bismarck in 1882 was 171, as against 43 in 1886.

The Northern Pacific Railroad was advanced from Bismarck in 1879 and 1880, though it does not touch the navigable portion of the Missouri River after leaving that place.

The St. Paul, Minneapolis and Manitoba Railway reached Benton, the present head of steam-boat navigation, in 1887, and freight of certain kinds that could formerly only reach Benton by water can now reach that point by rail.

Whether any decrease in river shipments to or from Benton that may immediately follow the completion to and beyond that point of the St. Paul, Minneapolis and Manitoba Railway will be offset by the opening to settlement of the Great Sioux Reservation, or by the facilities for river transportation that the Government improvement of the Upper Missouri River will give, so as to retain for Bismarck its prominence as a river shipping point or to add to such prominence, can not be predicted in this report.

As to the United States steamer, dredge, etc., operating for improvement of the upper river, this fleet has been, and undoubtedly will be for some time to come, principally engaged upon the portion of the river between Benton and Carroll, the latter 655 miles above Bismarck. Ice is liable to form in that portion of the Missouri as early as October 20, though it may not form for many days thereafter. If the boats engaged upon the upper river improvement were to make Bismarck for winter quarters in time to guard against being caught on the way on account of low water (which almost invariably occurs in the fall of the year) and being frozen in for the winter, much time each season would be sacrificed in reaching the harbor. That a United States steamer has laid up for several winters at Rock Haven does not furnish assurance that it will always be so laid up. The United States dredge engaged upon the upper river was laid up last winter at Rowe's Bayou, Montana, about 15 miles below Benton. The fleet of United States boats engaged in improvement of the lower river, *i. e.*, from Sioux City to the mouth of the Missouri, would not, in all probability, find it advisable to travel 650 to 1,450 miles, to Bismarck, to find a winter harbor, and it is not assumed that the advocates of such a harbor meant to be understood as expecting that fleet to use it.

Various suggestions have been offered as to the construction of the harbor asked for, such as (1) building stone dikes on foundations of brush high enough to protect steamers from the heaviest ice-floods; (2) *excavation* for an artificial basin; (3) securing the upper end of the

Rock Haven bank against erosion by a pier of masonry to rest upon the outcropping ledge of rock, a dike of earth to connect the pier with high ground, so as to intercept masses of ice that may be swept by gorge-floods across the Rock Haven prairie in such manner as to endanger boats from that side.

The Missouri River below Carroll flows over an unstable and shifting bottom, and its banks are generally unstable. The river carries a large percentage of earthy matter in suspension, and which, wherever the velocity of the current is much reduced, is immediately deposited. This is so well known to all who are familiar with the Missouri River that it is not necessary to produce any facts here in support of the statement.

High dikes, to inclose sufficient space to accommodate sixteen steamers and upwards, and to be of sufficient strength to resist the movement of ice, would be very expensive, to say the least. They would cause heavy deposits of Missouri River sand and mud below them, thus blocking up the entrance to the harbor at low and medium stages of water, and deposits of mud would also occur within the area inclosed by them. These deposits, in order that they might not interfere with the use of the harbor during the stages of water mentioned, would have to be removed, probably every season, by some form of dredging-machine or sand-pump, and even then there would be no surety that the operation, once performed, would not have to be repeated during the same season. A winter or ice harbor should be accessible to boats at all stages of the river. The same objections, viz, expense of construction and of maintenance, apply to the excavation of a basin. The suggested pier and dike would not add to the capacity of Rock Haven as a harbor, and as the bank at that point did not appear to be wearing, and as there was no decided testimony that ice from that side had ever seriously threatened the safety of steam-boats properly manned and cared for during spring "break-ups," the necessity for such construction is not apparent.

As to cradle-ways, steam-boat owners generally object to hauling their boats out of the water, except for repairs; besides, ways should be built by private enterprise.

It does not appear likely, from all that I have been able to gather, that more than four or five steam-boats will winter in the vicinity of Bismarck, for the present at least. Their value is small as compared with the ultimate cost of constructing and maintaining an ice-harbor, the necessity for which has not been clearly shown. I am, therefore, of opinion that no further examination of the locality, with a view to creating an ice harbor, need be made.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

The CHIEF OF ENGINEERS, *U. S. A.*
(Through Col. O. M. Poe, Corps of Engineers,
Division Engineer of the Northwest Division.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Detroit, December 21, 1888.

Respectfully forwarded to the office of the Chief of Engineers.
I concur in the conclusions reached by Major Allen.

O. M. POE,
Colonel of Engineers,
Engineer Northwest Division.

a.—LETTER ADDRESSED TO CAPTAINS W. H. GOULD AND JOSEPH TODD.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., November 6, 1888.

DEAR SIR: I am collecting information concerning a suitable winter harbor for steam-boats on the Missouri River, at or near Bismarck, and would be much obliged if you would assist me by answering the following questions:

1. How many safe natural harbors are there in the vicinity of Bismarck for wintering steam-boats and protecting them against the movement of ice in the spring; and how many boats can each accommodate?

2. How many steam-boats can be safely harbored at Rock Haven, just above Mandan?

3. Have any steam-boats been lost at Rock Haven from action of ice either in the fall or during spring break-ups; and, if so, have they been lost through any cause excepting inexperience of the persons who laid the boats up, or negligence of watchmen in charge of them? In other words, have any boats been unavoidably lost at Rock Haven?

4. If any boats have been lost or sunk at Rock Haven, will you please state how many; what their names were; and who laid them up? Also, the cause of their being lost or sunk.

5. If there were a safe and capacious winter harbor at or near Bismarck, would steam-boats leave Omaha, Sioux City, Yankton, or other points on the Missouri River, in time to lay up there (at on near Bismarck) for the winter; and, if so, how many steam-boats?

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

Capt. W. H. GOULD,
Yankton, Dakota.

(Same letter written to Capt. Joseph Todd, St. Louis, Mo., but no answer received.)

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b.—LETTER OF CAPTAIN W. H. GOULD.

YANKTON, DAK., *November* 8, 1888.

DEAR SIR: Replying to yours of 6th instant, I think Rock Haven the most secure harbor in the vicinity of Bismarck for the wintering of steam-boats, and will accommodate 6 or 8. Only one has been lost there, and that occurred through neglect of watchman, he allowing her to catch on the shore while the river was falling and fill with water from the outside. It was an old ferry-boat, of little value, and laid up there and owned by Captain Braithwait. Her name was the *Undine.*

I am of opinion no boats would go up the river in quest of winter harbors from this section, as they could be pulled out on top of the bank much cheaper than to take them so far.

Very respectfully,

W. H. GOULD.

Maj. CHARLES J. ALLEN.

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c.—LETTER OF MAJOR CHARLES J. ALLEN, CORPS OF ENGINEERS, TO CAPTAIN I. P. BAKER, SUPERINTENDENT BENTON TRANSPORTATION COMPANY.

UNITED STATES ENGINEER OFFICE,
St. Paul. Minn., November 21, 1888.

DEAR SIR: Referring to your conversation with Mr. Powell and myself, at Bismarck, last month, concerning a proposed ice-harbor at or near that place: Will you kindly embody in a letter to myself your views as to the necessity for such a harbor, and also state the number of steamers, and sizes of same, that would probably winter in the harbor if one should be constructed?

Section 14 of the river and harbor act of Congress, of August 11, 1888, provides, in regard to a survey for the ice-harbor in question, as well as for other surveys authorized by the act, "That no survey shall be made of any harbors or rivers until the Chief of Engineers shall have directed a preliminary examination of the same by the

local engineer in charge of the district, or an engineer detailed for the purpose; and such local or detailed engineer shall report to said Chief of Engineers whether in his opinion said harbor or river is worthy of improvement, and shall state in such report fully and particularly the facts and reasons on which he bases such opinion, including the present and prospective demands of commerce; and it shall be the duty of the Chief of Engineers to direct the making of such survey, if, in his opinion, the harbor or river proposed to be surveyed be worthy of improvement by the General Government; and he shall report to the Secretary of War the facts and what public necessity or convenience may be served thereby, together with the full reports of the local engineer: *And provided further*, That the Government shall not be deemed to have entered upon any project for the construction or improvement of any water-way, harbor, or canal mentioned in this act unless or until the work of construction shall have been actually appropriated for. Said reports of preliminary examinations and surveys shall be made to the House of Representatives, and are hereby ordered to be printed when so made."

You will see from the foregoing that a regular survey for an ice-harbor at or near Bismarck can not even be made until it is shown that the locality is "worthy of improvement," by which is meant, so far as I understand, that an improvement (ice-harbor) is needed in the interest of present and prospective navigation.

It will assist me greatly in discussing the subject if you will state in the letter asked the number of steam-boats that have been engaged on the Upper Missouri River for a number of years past, the amount of freight carried by them, and the probable increase in the same.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

Capt. I. P. BAKER,
Superintendent Benton Transportation Company,
Bismarck, Dakota.

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d.—LETTER OF MAJOR CHARLES J. ALLEN, CORPS OF ENGINEERS, TO CAPTAIN I. P. BAKER, SUPERINTENDENT BENTON TRANSPORTATION COMPANY.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., November 30, 1888.

DEAR SIR: I wrote you on the 21st of this month, asking you to kindly embody in a letter to myself your views as to the necessity for an ice-harbor at or near Bismarck, and also to state the number of steamers, and sizes of same, that would probably winter in the harbor if one should be constructed. Also, asking for some navigation statistics.

Not having heard from you in answer, it seems possible that you may not have received that letter.

I should be glad to hear from you at an early date.

Respectfully, yours,

CHAS. J. ALLEN,
Major of Engineers.

Capt. I. P. BAKER,
Superintendent Benton Transportation Company,
Bismarck, Dakota.

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e.—LETTER OF CAPTAIN I. P. BAKER, SUPERINTENDENT BENTON TRANSPORTATION COMPANY.

BISMARCK, *December* 4, 1888.

DEAR SIR: Respectfully replying to your communication relative to the matter of constructing an "ice-harbor" and the use of the same by steam-boats on the Upper Missouri River, please permit me to suggest that a place called "Rock Haven," situated about 5 miles above this place, offers some natural advantages; and the landing at Bismarck, below the bridge, in our opinion could be utilized by the Government in constructing at a reasonable expense a permanent and safe winter harbor for its own river improvement fleet of boats and barges, as well as the various boats navigating the river. This company operates 4 boats ranging in size from 150 to

450 tons capacity. I can not furnish you a list of boats of all classes operating above Sioux City, Iowa.

We believe the traffic on the Upper Missouri River will increase in view of the Territories of Dakota and Montana becoming States at an early day, and the increased emigration which will naturally follow. As yet the lands bordering on the Upper Missouri River are mostly vacant or occupied by Indians who have recently been treating with the Government with view to throwing open the river lands for settlement by whites.

It is a well-known fact that owners of steam-boats can not insure against the damage by ice break-ups in the Upper Missouri, and as all floating property is jeopardized each spring by such "break-ups" the necessity for an ice-harbor is very clear and plain.

I have not at my command statistics showing the tonnage of steamers plying the Upper Missouri River, nor the gross tonnage transported. I think, however, you can obtain it from the reports of Captains Maguire and Sears, United States Engineers.

Very respectfully,

I. P. BAKER.

Maj. CHARLES J. ALLEN,
United States Engineer.

APPENDIX C C.

IMPROVEMENT OF TENNESSEE AND CUMBERLAND RIVERS, AND OF CERTAIN RIVERS IN EASTERN TENNESSEE AND KENTUCKY.

REPORT OF LIEUTENANT-COLONEL J. W. BARLOW, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Tennessee River.
2. French Broad River, Tennessee.
3. Hiawassee River, Tennessee.
4. Clinch River, Tennessee.
5. Cumberland River, Tennessee and Kentucky.
6. South Fork of Cumberland River, Kentucky.
7. Caney Fork River, Tennessee.

UNITED STATES ENGINEER OFFICE,
Nashville, Tenn., July 15, 1889.

GENERAL: I have the honor to transmit herewith the annual reports upon the river and harbor improvements in my charge for the fiscal year ending June 30, 1889.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

CHIEF OF ENGINEERS, U. S. A.

C C 1.

IMPROVEMENT OF TENNESSEE RIVER.

	Miles.
From mouth of North Fork of Holston (Kingsport, Tenn.) to Paducah, Ky	808
From mouth of French Broad River to Paducah, Ky	650
From mouth of Little Tennessee River to Paducah, Ky	600
From mouth of Clinch River to Paducah, Ky	567

The Tennessee is an affluent of the Ohio, and ranks as one of the most important of the forty-five or more navigable rivers tributary to the Mississippi. The Tennessee River, so-called, is formed by the confluence of two of the several mountain streams draining the Cumberland and the Blue Ridge. Authorities have differed as to the exact waters whose united streams shall form the Tennessee—the Riviere des Cheraquis of the early French explorers, and the Cherokee River of Indian cessions to England in 1767. Some geographers and ency-

clopedists have held that the Tennessee is formed by the junction of the Clinch and Holston rivers, near Kingston, Tenn.; others that the chief town of the Cherokees being at Tennassee, on the west bank of a stream bearing the same name—now known as the Little Tennessee—which, joining the Holston, gave the name of Tennessee to the river and the State.

The act of 1871, making appropriation by the General Government for the improvement of the Tennessee River, directed its expenditure between "Knoxville and Chattanooga," thus giving apparent legislative sanction to the application of the name, Tennessee, to the stream formed by the confluence of the French Broad and Holston rivers, about 5 miles above Knoxville.

It is understood that the State of Tennessee some years ago sought to enact appropriate legislation to settle this vexed question, but though such a bill passed the general assembly, it failed of executive approval.

During the last session of the legislature of Tennessee the matter was again considered, and the following law is now found among the acts of Tennessee:

AN ACT to settle all doubts and disputes as to the name and source of the Tennessee River.

Whereas diverse opinions exist as to the true source of the Tennessee River, thereby causing confusion in statutes, deeds, and other instruments: Now, therefore, and in order definitely to establish the name and source of said river—

SECTION 1. *Be it enacted by the General Assembly of the State of Tennessee*, That the Tennessee extends from its junction with the Ohio River at Paducah, in the State of Kentucky, past the Clinch and French Broad rivers to the junction of the north fork of the Holston River with the Holston, at Kingsport, in Sullivan County, Tennessee, all usages to the contrary notwithstanding.

SEC. 2. *Be it further enacted*, That this act take effect from and after its passage.

Passed April 6, 1889.

BENJ. J. LEA,
Speaker of the Senate.
W. L. CLAPP,
Speaker of the House of Representatives.

Approved April 6, 1889.

ROBT. L. TAYLOR,
Governor.

A correct copy:
C. A. MILLER,
Secretary of State.

Under this legislation, the term "above Chattanooga," as applied to the Upper Tennessee, will reach Kingsport, Tenn.

It is suggested that Congress definitely determine in its next appropriation for the work "above Chattanooga" the points between which the funds shall be expended.

This stream is navigable from its source to its mouth, excepting at the Muscle Shoals, in Alabama, which form a complete barrier to all navigation, except when the water is at unusually high stages.

The extent of the navigability of its upper waters is, of course, to be determined by the location of the confluent waters held to form the Tennessee proper.

1. ABOVE CHATTANOOGA 194 MILES.

In 1830 a detailed examination was made of this section of the river, and extending to the Alabama State line, by Lieut. Col. S. H. Long, United States Topographical Engineers, and his report to the then Board of Internal Improvement for East Tennessee is published as Ex. Doc. No. 167, Forty-third Congress, second session.

In 1871 a re-examination was made between Knoxville and Chattanooga. (See Reports of Chief of Engineers 1871, page 502 *et seq.*, and 1872, page 488 *et seq.*)

These examinations show that the principal obstacles are "low water" obstructions, rock reefs, sand and gravel shoals. A few snags are brought down by the annual floods, but the bed and banks of the Upper Tennessee are subject to only slight changes from year to year; therefore improvements when made are practically permanent. Some work was done in 1832 by the State of Tennessee, based upon the plans proposed by Colonel Long in his report above referred to.

The first appropriation ($50,000) made by the United States for the improvement of the Upper Tennessee was in 1852, and was expended under the direction of Col. J. McClellan, United States Topographical Engineers, in 1853–'56, in clearing the channel of loose rock, snags, etc., and building wing-dams and providing aid for warping boats through swift water.

The present project is based upon the examination made in 1871. The estimates, however, then submitted were increased in 1874, 1877, and 1884 for the reasons stated in reports for those years, and the work projected is to blast a channel through the reefs, to excavate the sand and gravel bars, and to build riprap dams to contract the water-way where necessary, so as to secure a safe, navigable channel-depth of about 3 feet at extreme low water.

Ten appropriations, from July 11, 1870, to August 11, 1888, inclusive, have been made by Congress for this work, aggregating the sum of $241,000.

The amount expended to June 30, 1888, was $225,947.70, which has secured for commerce a lengthened season of navigation for steamboats and an improved channel for the passage of rafts and flat-boats, in which the commerce of the Upper Tennessee largely consists. Of the 43 obstructions enumerated by Colonel Long, work has been done upon at least 29 of the principal of them, partially removing some and more or less improving others. A snag and tow boat was also built, and paid for in part from the above appropriation, for use upon this stream and its tributaries.

Work was resumed at Soddy Shoals in October last, as soon as stage of water permitted, and continued at that point and at White Creek Shoals until December, when the boats, etc., were placed in care of watchmen for the winter.

The snag-boat *Weitzel* was also employed during the month of December removing snags and overhanging trees, etc., from the channel between Chattanooga and White Creek, a distance of about 114 miles.

The amount thus expended to June 30, 1889, including outstanding liabilities, was $5,135.87.

Location.	Excavation, solid rock.	Quarrying.		Riprap dams built.	Snag-boat.	
		Stripping.	Riprap.		Snags removed.	Trees cut down.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*No.*	*No.*
Soddy Shoals	5	.....	.....	30	.....	124
White Creek Shoals	.....	965	577	471	12	794
U. S. snag-boat *Weitzel*, snagging from Chattanooga to White Creek, 114 miles	.....	.....	.....	.....	30	954
Total	5	965	577	501	42	1,872

The commerce of the Upper Tennessee and its tributaries is growing rapidly. The accompanying commercial statistics by no means show the entire commerce of the stream, for many rafts and flat-boats with their cargoes are disposed of at points at which it is impracticable to obtain data.

The amount herein asked for, $50,000, can be profitably expended in continuing work under the existing project by snagging and by channel excavation and construction of wing-dams at those obstructions between Chattanooga and the mouth of the French Broad River; which, upon further examination, may be found to demand immediate work, as being most serious obstacles to navigation.

The prospective demands of the commerce and navigation of the Tennessee will probably require before many years a new project with revised estimates, having in view a radical improvement of its upper waters, resultant from an open navigable lower river to the great Mississippi system, by the opening of the Muscle Shoals Canal, and also by reason of the improvement of its copious upper river tributaries.

The estimates for improving Tennessee River above Chattanooga amount to	$300,000.00
Amount appropriated	241,000.00
Amount expended	231,038.46

Money statement.

July 1, 1888, amount available		$52.30
Amount appropriated by act of August 11, 1888		15,000.00
		15,052.30
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$5,027.36	
July 1, 1889, outstanding liabilities	63.40	
		5,090.76
July 1, 1889, balance available		9,961.54
Amount (estimated) required for completion of existing project		59,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

II.—BELOW CHATTANOOGA (456 MILES).

The opening of the Lower Tennessee River by means of a canal around the Muscle Shoals was favorably considered by the General Government for many years before action was taken in the matter.

In 1824, during the administration of President Monroe, the then Secretary of War, John C. Calhoun, asserted that the improvement of this obstruction was of national importance.

In 1827 the Board of Internal Improvement, Brig. Gen. S. Bernard, Lieut. Col. James Kearney, and Maj. William Tell Poussin, examined that portion of Tennessee River extending from Brown's Ferry to Waterloo, Ala., and made its report May, 1828.

Congress, during the same month, granted to the State of Alabama 400,000 acres of United States lands to be applied principally to the improvement of the navigation of the Muscle Shoals and Colbert Shoals.

The Board of Internal Improvement, in April, 1830, submitted a project consisting of a canal from Brown's Ferry to Florence, and of the removal of obstructions from Florence to Waterloo, about 28 miles.

In 1867 an examination was made from Chattanooga, Tenn., to Paducah, Ky.

An instrumental survey of the three divisions of the entire chain of obstructions known as the Muscle Shoals was completed, and upon that the present project is based, modified, however, as to the character of work done at Little Muscle Shoals and as to the change of location of the canal from the north side to the south side of the river at Elk River Shoals.

The resurvey of the last-named division was made in 1877.

The Muscle Shoals extend from deep water at Brown's Ferry to deep water at Florence, a distance of 38 miles, only 8 miles of which were navigable.

From Chattanooga, Tenn., to Decatur, Ala., the section of river above the Muscle Shoals, there is much work to be done at several of the obstructions, especially at the "Suck" and the Bridgeport and Guntersville bars.

Below the Muscle Shoals, from Florence, Ala., to the mouth of the river, the principal obstructions are at Colbert Shoals and Duck River Shoals, though there are other obstacles of minor importance that require attention.

As the Muscle Shoals, the rocky bearer that effectually closes navigation, must necessarily be overcome before the river can be utilized to any great extent, it has been heretofore for this reason held advisable to press forward that work to completion before submitting any projects and revised estimates for the radical improvement of other portions of the channel, either above Decatur or below Florence.

The existing project, with estimates, is—

(1) To enlarge, rebuild, and straighten the old work at Big Muscle Shoals by constructing a canal 14½ miles long, having 9 locks with a total lift of 85 feet, and an aqueduct 900 feet long and 60 feet wide over Shoal Creek, with the necessary permanent dams and bridges over the several creeks and ravines, the canal trunk to be from 70 to 120 feet wide at the water surface and 6 feet deep, and the locks 300 feet long, 60 feet wide, and having a depth of 5 feet of water on the miter-sills.

(2) To construct at Elk River Shoals a canal 1½ miles long, with 2 locks having lifts of 12 feet and from 5 feet to 9 feet, respectively, and of same dimensions as the locks at the Big Muscle Shoals.

(3) To blast at Little Muscle Shoals a channel through the bed-rock of the river, and to construct stone wing-dams and retaining-walls, to contract the water-way and to check the velocity of the current at certain points.

(4) To remove or reduce the worst obstructions above Decatur and below Florence to the limited extent that may be imperative to assist low-water navigation, having in view the submission of plans and revised estimates for a radical improvement of the various obstructions.

The total amount appropriated for the improvement as above projected "below Chattanooga" aggregates the sum of $3,208,000. Of this sum $2,957,377.28 had been expended at the close of the fiscal year ending June 30, 1888, and this expenditure has resulted in the improvement of the river as follows:

The practical completion, as modified, of the work at Little Muscle Shoals at a cost of about $126,180, by cutting a channel through the bed-rock 2½ miles long, and building about 3 miles of stone dams.

It may, however, become necessary in the near future to make modifications of the existing dams, or to build locks, as originally projected and estimated for.

At *Big Muscle Shoals* and Elk River Shoals the eleven locks were built and all the miter gates placed in position. The five lower locks are to have drop gates, and one of these, at Lock 5, was hung.

The Shoal Creek Aqueduct was practically erected as a structure, though considerable work remained to be done to place it in an actually finished condition for use.

Necessary widening and straightening of the canal trunk was effected; the permanent dams at Bluewater Creek and Six Mile Creek, and the Douglas Branch Bridge, were built.

A dredge and dump-scows and snag-boat were built for use upon the work.

During the fiscal year, at the Big Mucle Shoals, the principal work done consisted of rock and earth excavation from prism of canal throughout its length. Three long waste-weirs to preserve the tow-path from washing in times of flood, in the levels between locks 1 and 2, 3 and 4, and 5 and 6, were excavated and paved with masonry.

Drift-sluices are to be placed at the head of Locks 2, 4, and 6, respectively, to carry off the logs, drift, etc., brought down by freshets from the several feeders; the sluice at Lock 6 is nearly completed; another is well under way; the third will be built soon. As the canal approaches completion the work is necessarily largely miscellaneous in character; painting iron-work of locks and bridges; excavating wells for maneuvering gears; making foot-walks on bridges and lock-gates and fitting bridge irons; connecting gears of drop-gates with masonry; fitting and placing culvert valves and sills, etc.

A large quantity of filling was placed in tow-path and above and behind Lock 6; slope wall was laid on sections 3, 6, 7, 8, and 12; snubbing-posts were put in at the several locks to assist navigation.

Locks Nos. 1, 2, 3, *and* 4, with their gates, lock-bridges, and maneuvering appliances, are complete and ready for use.

Lock No. 5 is also ready, with the exception of foot-walk on drop-gate bridge.

Lock No. 6 is complete, excepting draw-gate bridge.

Lock No. 7 is complete, except bridge-plank on miter-gates and track-way for one spar-beam; drop-gate bridge not yet in place.

Locks Nos. 8 *and* 9 are complete, excepting putting on the chains for supporting drop-gates in position.

Shoal Creek Aqueduct is finished and will be ready for use when certain miscellaneous work is done—some bolting and leading, and applying a coating of coal-tar pitch to its entire bottom, preserving it from rust and preventing leakage.

A design for a movable dam, to be put in below Lock 9, has been prepared and material purchased. This dam will be required should it ever become necessary to pump out Lock 9. The work has been delayed by high water, but it will be completed soon.

Location.	Excavation, earth, etc.	Embankment.	Quarrying.		Stone-cutting.		Masonry.	
			Dimension stone.	Riprap.	Superficial feet.	Cubic yds.	Cut stone.	Rubble.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*			*Cu. yds.*	*Cu. yds.*
Section No. 2	760							
No. 3, slope wall				1,120				40
No. 4	1,265			422				
No. 5	6,671							
No. 6, slope wall	4,266							235
No. 7, slope wall	540			352				64
No. 8, slope wall	50							120
No. 9	560			26				
No. 10	2,411							
No. 11	11,299			11				
No. 12, slope wall								352
Cross-dam, Douglass quarry	226							
Waste-weirs	9,531							
Paving weirs								8,474
Filling in tow-path		25,000						
Filling in behind Lock 6		10,000						
Lock 6							55	
Lock 7 culvert								148
Bluewater Bridge								140
Lock "A," Elk River Shoals*			308	74	598	25½		
Totals	37,549	35,000	308	2,005	598	25½	55	4,573

At the Shoal Creek Aqueduct a culvert has been built to drain the level above Lock 7, and the following miscellaneous work done: Masonry of piers dressed for receiving iron-work to strengthen piers; shearing, bending, punching braces; drilling beams and connecting plates; painting iron-work, etc.

That the work is approaching a finished condition may be readily shown by the fact that in April last the United States steamer *Weitzel* made the passage of the two locks of the upper division (Elk River Shoals), and through the first six locks of the lower division; thus completing the passage of all the locks, except Nos. 7, 8, and 9. The lock-gates and maneuvering appliances of the miter-gates and drop-gates operated very satisfactorily. Some work yet remains to be done to thoroughly finish the aqueduct for use; when this is completed and the coffer-dam below Lock 9 is removed, the gates and maneuvering appliances of the three lower locks can then be tested, the locks passed, and practically the canal will be completed to an extent sufficient to permit of the passage of boats, though much miscellaneous work will be necessary to place the canal in a thoroughly finished and efficient condition.

Plats of the lands required on this division for sites of lock-keepers' house, store-houses, and repair-shops, etc., required in the operation and maintenance of the canal, were approved in March last and action was at once taken to buy the land from its several owners.

Agreements, subject to approval of Secretary of War, were first reached with the owners of a part of the land required at Lock 6, and abstracts of title have been prepared and sent to the Department of Justice for examination and opinion; these abstracts pertain to the land of Benjamin Cross, three acres, and of Mary A. Reilly, fifteen acres. As soon as title is approved and purchase authorized, action will be taken for the erection of the buildings required. Amount expended, $50,510.58, on Muscle Shoals Division.

At Elk River Shoals active operations were resumed in September,

as soon as the funds appropriated by act of August 11, 1888, were available for expenditure.

The break in the embankment made by the heavy storm of January last was closed by a permanent crib filled with stone and clay.

The embankment, when the break occurred, was unfinished, but had been in position several years, and was believed to be secure, but it was not sufficiently strong to resist the sudden and violent flood.

While the work of filling the break was in progress, the embankment was also built up, thus leaving it in a more nearly finished condition than at the time of the accident.

The United States dredge *Harwood* has done considerable scattered dredging; excavating below lock B, removing stone from cross-dam at Milton's Bluff; excavating two cuts from cross-dam to and through first tow-head, the material being put in dam above lock A, together with about 3,000 cubic yards of spalls, etc., from the quarries.

Below Lock B the unfinished slope-wall was completed, and also the culvert behind crib-work at Lock A.

Much miscellaneous work was done on this division. Repairs of steamer *Elk*, stone-barges, etc., making new wood-work for crab-frames and horse-powers; building boat-ways; repairing locomotives, cars, etc., moving fuel, forage, and other supplies to the lower division.

Fully 2 miles of railroad track have been laid.

At Locks A and B, culvert-irons were put in, gate-walks and bridge-rails placed in position, lock-gates painted.

The two locks of this division are ready for actual use with the hand-maneuvering appliances now in position, but it is proposed to apply at Lock A certain hydraulic machinery; plans for which have been approved, for test as to its efficiency and practicability, which if found to be satisfactory will be applied at each of the locks of the entire series.

One set of this machinery will be constructed early in the next fiscal year.

A force was organized to begin channel excavation at Nance's Reef. The barges, with drilling outfit, were in readiness at the close of the fiscal year, and one section was drilled and blasted.

Amount expended was $26,224.23 on Elk River Shoals division.

Excavation:		
Stone removed from longitudinal dam opposite Milton's Bluff	cu. yds.	102
Dredge-boat *Harwood*, dredging out cross-dam, tow-head, etc	do	7,373
Quarrying:		
Stripping	do	3,007
Riprap stone	do	425
Masonry:		
Dry slope-wall, canal-trunk	do	266
Stone laid in culvert-arch	do	223
Dams:		
Clay and gravel placed in dam above Lock "A"	do	2,105
Riprap placed back of crib and dam above Lock "A"	do	4,431
Stone placed in temporary cross-dam opposite Milton's Bluff	do	968
Earth	do	310
Permanent crib-dam. Lumber	feet, B. M.	125,000
Stone and clay filling	cubic yards	1,123
Temporary crib-dam at Lock "A." Earth and stone filling	do	150
Stone filling in break in towpath above Lock "A"	do	440

A small tug-boat for use in the canal-trunk is building at Chattanooga, and will be finished in July and dropped down to the canal for immediate service.

The U. S. snag-boat *Weitzel*, at sundry times during the year, was employed in towing coal-barges, etc., from Chattanooga to the Muscle Shoals.

The river having reached a favorable stage about the middle of May, this snag-boat was put at work snagging a stretch of river about 119 miles long, extending from 6 miles below Decatur, Ala., to 20 miles below Bridgeport, removing 156 snags, ranging in size from 8 inches to 60 inches in diameter.

Some smaller drift was also taken out, but no special record kept of anything less than 8 inches diameter.

The river rose rapidly in June, and this work was necessarily suspended during that month.

Bench-marks were established at various points on the river, from the mouth of the French Broad River to Paducah, Ky., to aid in determining the uniform high-water grade-lines upon the Tennessee and Cumberland rivers and their tributaries, over which bridges are or may be constructed under authority of Congress.

It is evident that a rapid means of communication along the extended line of works has become a necessity for an efficient prosecution of the work and operation of the canal when completed. Authority was granted in June to construct a telephone line between the two divisions of the canal, and extending throughout its entire length, a distance of about 25 miles. This line will be built early in the next fiscal year, preliminary arrangements having been made for the necessary material.

Total amount expended during fiscal year, including outstanding liabilities, $110,112.88.

The number of bridges now spanning the Tennessee River, when taken in connection with the number proposed to be constructed under the recent enabling acts of Congress, forms a very important matter for consideration where the interests of navigation are concerned.

All bridges are obstructions, in a greater or less degree, and it is highly desirable that all new bridges be constructed with a view to securing in those having continuous spans a certain width and height above high water in their navigation spans and in draw-bridges, a certain uniform width of clear water-way in their draw-spans.

There are now ten bridges over the Tennessee River, each one of which requires some modification, more or less necessary and costly, to cause navigation through or under them to be free, safe, and unobstructed, and in a reasonable degree to conform to the requirements for the thirteen or more bridges proposed to be constructed under recent Congressional sanction.

The character of some of these old bridges is presented in Report of Chief of Engineers (1888), page 2638 *et seq.*

These structures will become more and more objectionable upon the opening of the Muscle Shoals Canal in the near future, and it is obligatory that these bridges be modified without delay, so that the canal can be utilized as soon as opened.

It is understood that the lessees of the Memphis and Charleston Railway are ready at once to begin the work of modifying the bridge at Florence, Ala., which now forms an absolute barrier to ordinary steamers.

The removal of the rest-piers of the Gilbertsville Bridge has been partly done, but the safety of navigation is not secured until the piers are wholly removed to a depth not less than 6 feet below extreme low-water mark.

It is urgently recommended that such exact legislation be enacted as will procure the modification of all existing bridges spanning the Tennessee, to the extent necessary to secure free and safe navigation making them to conform to the present requirements for new bridges.

The following is a list of existent and recently authorized bridges, so far as could be obtained.

List of bridges, constructed or to be constructed, over the Tennessee River.

EXISTING BRIDGES (10).

Location.	Operated by.
Knoxville, Tenn	County.
Do	East Tennessee, Virginia and Georgia Railroad.
Loudon, Tenn	East Tennessee, Virginia and Georgia Railroad.
Chattanooga, Tenn	Cincinnati Southern Railroad.
Bridgeport, Ala	Nashville, Chattanooga and St. Louis Railway.
Decatur, Ala	East Tennessee, Virginia and Georgia Railroad.
Florence, Ala	East Tennessee, Virginia and Georgia Railroad.
Johnsonville, Tenn	Nashville, Chattanooga and St. Louis Railway.
Danville, Tenn	Louisville and Nashville Railroad.
Gilbertsville, Ky	Newport News and Mississippi Valley Company.

For detailed description see Report of Chief of Engineers, 1888, page 2565.

NEW BRIDGES AUTHORIZED BY CONGRESSIONAL SANCTION (13 OR MORE).

Location.	To be built by—	Date of act.
Knoxville, Tenn	Car., Knoxville and Western Ry. Co	June 25, 1888
Do	Knoxville Southern Ry. Co	Aug. 9, 1888
Chattanooga, Tenn	Chattanooga Bridge Company	Apr. 20, 1888
Do	Chattanooga Western Ry	June 9, 1888
Do	Memphis and Charleston R. R. Co	Feb. 28, 1887
Guntersville, Ala	Tennessee and Coosa R. R	June 9, 1888
Between Bridgeport and Sheffield, Ala	Cincinnati and Birmingham R. R. Co	July 16, 1888
Lamb's Ferry or Milton's Bluff, Ala	Cincinnati, Nashville and N. O. R. R. Co	Aug. 6, 1888
Milton's Bluff, Ala	Gulf and Chicago Air Line Ry. Co	Mar. 2, 1889
Foot of Muscle Shoals	Tennessee Bridge Company	Mar. 31, 1887
Sheffield, Ala	Sheffield, Land, Iron and Coal Co	Mar. 3, 1887
Any point below Aurora, Ky	Cairo and Tennessee River R. R. Co	Jan. 8, 1889

LITTLE MUSCLE SHOALS.

An examination of the dams upon this division, built in 1879–'81, has been made during the fiscal year, and demonstrated the need of extensive repairs of at least four of them; large breaks exist at the ends originally anchored to the islands, while those secured to the main shore remain comparatively intact.

A report, with estimates, pertaining to the further improvement of this division of the Muscle Shoals obstruction will be submitted during the next fiscal year.

It is very essential that an instrumental survey of the river below Chattanooga be made as soon as possible in order to obtain detailed maps of the obstructions, together with a complete profile of the river, so that estimates can be revised and projects for the radical improvement of the river below Chattanooga submitted, based upon the necessary and definite data that can only thus be obtained.

It is recommended that a survey of the Lower Tennessee from Chattanooga to mouth of river, excepting the Muscle Shoals, be authorized, for the reasons above stated.

COLBERT AND BEE TREE SHOALS.

Since the last annual report no additional surveys have been made of this obstruction, but a further analysis of the subject indicates that the estimates then presented ($923,000) will prove sufficient to build the two locks and dams required to overcome the fall upon the two shoals.

It is also found that by putting in longitudinal instead of cross dams and placing the locks in a side channel of the main river, that not only will the cost of the whole be somewhat diminished, but much more

satisfactory results will obtain, as this method will leave the main channel unobstructed and available at and above the medium stage.

The reduction in cost is due to the fact that owing to the great discharge of the river in comparison to its cross-section, fixed cross-dams will require lock-walls of excessive height to provide uninterrupted navigation during high stages of the river, while longitudinal dams, though necessarily of much greater length, will be of less height, and less expensive construction.

The recommendation for a liberal appropriation for carrying forward this work is urgently renewed to the end that the work may be commenced at the earliest practicable moment and continued to completion as rapidly as possible.

An improved river from Knoxville to Paducah will make the commerce of the Tennessee to take rank among the foremost of the many tributaries of the Mississippi. The following extract from the report of last year applies in an increased degree to the conditions at this time, which predict a prospective commerce of vast magnitude, in coal and iron especially, to an extent by which this river may rightfully claim to be one of the main commercial arteries of our vast and intimately connected system of navigable southern and western waters.

The prospective advantages to navigation, as well as present benefits to the community, by continuing the improvement to completion, not alone of the Muscle Shoals and the Colbert Shoals, but of the entire stream below Chattanooga, is held to be by the inhabitants of the Tennessee Valley well nigh incalculable.

The whole region is rapidly developing as one of the richest in coal and in iron and other mineral deposits, and all that seems necessary to the further development of these unquestioned resources is cheap transportation and an open river to the commercial centers of the Mississippi Valley.

The amount herein asked for ($1,500,000) can be profitably expended in completing the work at the Big Muscle Shoals and the Elk River Shoals, opening the canal to navigation, and in improving the Colbert Shoals by locks and dams, the only method that appears to promise satisfactory results; also to remove the sand-bars at Bridgeport and Gilbertsville and the surface obstructions below Chattanooga, including dredging and widening the low-water channel through the gorge in the mountains, improving the several obstructions enumerated in last annual report. (See page 1599 *et seq.*)

Original estimate of cost of improving the Tennessee River below Chattanooga	$4,133,000.00
Modified and increased, 1888	923,000.00
Total estimates	5,056,000.00
Amount appropriated	3,208,000.00
Amount expended	3,064,110.51

Money statement.

July 1, 1888, amount available		$622.72
Amount appropriated by act of August 11, 1888		250,000.00
		250,622.72
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$80,341.01	
July 1, 1889, outstanding liabilities	26,392,22	
		106,733.23
July 1, 1889, balance available		143,889.49
Amount (estimated) required for completion of existing project		1,848,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		1,500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Tennessee River, above Chattanooga, from July 1, 1888, to June 30, 1889.

Articles.	Quantities.	Articles.	Quantities.
Bricks ..... number..	2,500,000	Logs ..... feet, B. M..	20,000,000
Coal ..... tons..	35,000	Lumber ..... do....	2,000,000
Flour ..... barrels..	5,350	Merchandise ..... tons..	685
Grain ..... bushels..	1,960,000	Passengers ..... number..	60,000
Hay ..... tons..	1,260	Sand ..... cubic yards..	9,500
Iron ore ..... do...	125,000	Shingles ..... number..	12,000,000
Live stock ..... head..	87,500	Wood ..... cords .	1,500

Tennessee River, below Chattanooga and above Muscle Shoals, from July 1, 1888, to June 30, 1889.

Articles.	Quantities.	Articles.	Quantities.
Coal ..... tons..	9,500	Lumber ..... feet, B. M..	500,000
Cotton ..... bales..	6,800	Merchandise ..... tons..	9,000
Flour ..... barrels..	5,750	Sand ..... cubic yards..	35,000
Grain ..... bushels..	270,000	Passengers ..... number..	72,000
Hay ..... tons..	856	Iron ore ..... tons..	8,300
Live stock ..... head..	88,600		

Tennessee River, below Muscle Shoals, from July 1, 1888, to June 30, 1889.

Articles.	Quantities.	Articles.	Quantities.
Cotton ..... bales..	44,000	Pig-iron and ore ..... tons..	2,000
Grain ..... bushels..	210,000	Tobacco ..... pounds..	20,000,000
Lumber ..... feet, B. M..	30,000,000	Peanuts ..... bushels..	300,000
Logs ..... do....	24,000,000	Merchandise ..... tons..	500
Live stock ..... head..	16,500		

List of steam-boats plying on Tennessee River.

[Character: stern-wheel.]

Names of boats.	Length.	Breadth.	Depth.	Tons.
Above Chattanooga.	*Feet.*	*Feet.*	*Feet.*	
Citico	75	13.00	3.00	31.30
Dayton	142	24.07	3.08	357.49
J. R. Hughes	98	17.00	3.00	160.36
J. W. Russell	76	9.00	2.08	49.60
Myra	100	18.00	3.05	148.42
M. H. Cligt	105	18.00	3.05	164.00
May Tillman	79	15.00	3.00	32.72
P. Dickenson	122	28.00	4.00	205.97
Pin Hook	94	18.00	3.00	160.36
Rockwood	130	25.00	4.00	226.26
Tallassee	60	12.00	2.00	44.32
W. L. Dugger	130	27.00	3.08	224.13
W. L. Norton	68	12.00	3.00	63.01
Walter R. Love	112	18.00	3.05	173.53
Ella Durham	38	7.00	3.07	22.27
J. C. Warner	142	31.06	4.06	347.43

Names of boats.	Length.	Breadth.	Depth.	Tons.
Below Chattanooga and above Muscle Shoals.	*Feet.*	*Feet.*	*Feet.*	
J. H. Johnson	141.02	23.09	4.02	169.90
R. C. Gunter	133.00	28.00	4.00	565.34
Dixie	80.00	19.00	3.00	110.78
M. V. Reed	65.00	24.00	3.00	111.25
Herbert	134.00	27.00	3.00	167.00
Wyeth City	120.00	22.05	4.00	255.96
Below Muscle Shoals.				
John Gilbert	250.00	47.00	6.00	700.00
W. F. Nisbet	230.00	44.00	6.06	625.00
Clyde	206.00	40.00	5.06	450.00
City of Florence	183.00	37.00	5.03	425.00
W. H. Cherry	.....	.....	.....	.....
C. Smith	.....	.....	.....	.....
Allen J. Duncan	.....	.....	.....	.....
Silver Cloud	.....	.....	.....	.....
Crusader	.....	.....	.....	.....
A new packet for the trade of the Lower Tennessee is being built	190.00	32.00	6.00	*700.00

*About.

C C 2.

IMPROVEMENT OF FRENCH BROAD RIVER, TENNESSEE.

This stream rises in North Carolina, drains the western slope of the Blue Ridge, and enters the State of Tennessee near Paint Rock, about 121 miles above the junction of the French Broad with the Holston, thus forming the Tennessee River. In reference to this matter, see report for this fiscal year on the improvement of "Tennessee River above Chattanooga."

About fifty-three years ago the State of Tennessee appropriated money for improving the rivers forming the then so-called "East Tennessee district," and commissioners were appointed by that State to superintend the improvement of the Seven Island Shoals, about 30 miles below Dandridge.

Some dams were also built by the State above Dandridge. Several of these old State dams were repaired in 1881, but generally they have been removed in the progress of work under the present project.

As provided by the act of July 11, 1870, an examination was made of the waters of the French Broad flowing in the State of Tennessee.

Congress, by act of March 31, 1875, directed a re-examination of this stream "from its junction with the Holston at Knoxville to Leadvale, Tennessee." (See Report of Chief of Engineers, 1871, page 491, *et seq.*, and 1876, page 718, *et seq.*)

The estimate for 1871 for this section was re-submitted in 1876. The obstructions were found to be rock ledges, gravel bars, bowlders, snags, drift, etc.

The present project consists in removing surface obstructions, building rubble wing-dams, and deepening the channel over bars and ledges where necessary to obtain a channel depth of 2.5 feet at ordinary low water from mouth of river to Leadvale, about 90 miles, and having a probable average fall of 1 foot per mile in that distance. This stretch of river is exceptionally beautiful, broad, and well adapted to navigation in its lower course.

From mouth of Nolichuky River (Leadvale) to the Tennessee State line, a distance of about 31 miles, the river, having a fall of about 7 feet per mile, is not susceptible of improvement, without a system of locks and dams, at a cost wholly disproportionate to the benefits likely to accrue to its present or prospective commerce. Therefore the present project limits operations to the river below Leadvale.

The following appropriations have been made for this work:

Act of June 14, 1880	$10,000
Act of March 3, 1881	3,500
Act of August 2, 1882	5,000
Act of July 5, 1884	3,500
Act of August 5, 1886	6,000
Act of August 11, 1888	10,000
Aggregating the sum of	38,000

The total amount expended to June 30, 1880, was $28,000, which has been applied to the improvement of 11 of the principal obstructions below Leadvale, thereby securing an increased channel depth at low water from 6 inches to 10 inches. These improvements, though limited and incomplete, have given satisfaction to those having charge of rafts and flat-boats.

As a matter of economy in outlay for boats, superintendence, etc., act-

ive operations are carried on in connection with the work to be done on the Upper Tennessee and its tributaries, for which appropriations are made.

As soon as the stage of water permitted, early in March, the U. S. steamer *Weitzel* towed the boats, etc., from their moorings at White Creed, Tennessee River, to the Seven-Island Shoals, and by the middle of that month the work of quarrying stone for riprap dams was well under way.

An instrumental survey of the Seven-Island Shoals, Bryant's Shoals, and Moses Shoals was made with sufficient accuracy whereon to base plans for the necessary improvements of those obstructions.

At the Seven-Island Shoals, in the Wesley Chute, some gaps in the dams were closed, and the island dam was extended down-stream to deep water to scour the sand and gravel bar that had formed below the dams.

The velocity of the current made it frequently very difficult to run this chute, therefore the north dam was taken out, and its stone is to be used in partly building two spur-dams from the south dam to check the current and hold it back on the fall above. This work was progressing at the close of the fiscal year.

The red or north bank, behind Round Island, has been subject to erosion for several years, and a long gravel bar had formed below, making the channel crooked and difficult.

A crib-dam 95 feet long was built to change the current from the north bank, and the gravel was removed and placed in the crib-dam.

At the foot of Round Island the channel was cleared of the large "river rock," logs, etc., and six check-dams were built out from the north bank and one from the south bank, just below; these dams have had a marked effect in checking the velocity of the current.

It is proposed to construct another dam from the south bank a little further down-stream.

A small steamer was hired during June to tow stone-boats between the quarry and dams, and it was found to be very satisfactory and economical.

Amount expended during the fiscal year ending June 30, 1889, including outstanding liabilities, was $6,646.61.

Location, Seven-Island Shoals.	Trees cut down.	Snags removed.	Coffer-dam.	Rock and gravel excavation in channel.	Quarrying.		Dams built.
					Stripping.	Riprap.	
	No.	*No.*	*Lin. ft.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
Greens's Bar	.....	.....	.....	20	.....	.....	.....
Green's Bar and foot of island	.....	.....	.....	363	.....	960	.....
Round Island Chute	.....	.....	95	1,450	.....	.....	.....
Wesley Chute	69	40	.....	144	.....	.....	104
Seven-Island Shoals	.....	.....	.....	.....	727	2,083	1,630
Total	69	40	95	1,977	727	3,043	1,734

The commerce of the French Broad River is rapidly increasing, and the extending of the facilities offered by this improvement will materially aid in the development of the mineral wealth and rich agricultural lands of the region drained by this river and its tributaries.

The amount herein asked for ($30,000) can be profitably expended

under the present project in the improvement of the shoals found on examination to be the most serious obstructions to navigation between Leadvale and mouth of the river.

The estimate of cost of improving French Broad River, Tennessee, from mouth of river to Leadvale	$150,000.00
Amount appropriated	38,000.00
Amount expended	34,602.17

Money statement.

Amount appropriated by act of August 11, 1888		$10,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$5,034.81	
July 1, 1889, outstanding liabilities	1,567.36	
		6,602.17
July 1, 1889, balance available		3,397.83
Amount (estimated) required for completion of existing project		112,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics from July 1, 1888, to June 30, 1889.

Articles.	Quantities.	Articles.	Quantities.
Grain ..... bushels..	280,400	Wood ..... cords..	160
Hay ..... tons..	140	Marble ..... cubic yards..	6,000
Live stock ..... head..	420	Sand ..... do....	36,000
Logs ..... feet, B. M..	6,500,000	Stone ..... do....	7,200
Lumber ..... do....	2,000,000	Merchandise ..... tons..	5,850

C C 3.

IMPROVEMENT OF HIAWASSEE RIVER, TENNESSEE.

This stream rises in Georgia on the western slope of the Blue Ridge. Its course is nearly at right angles to the Tennessee River, which it enters at a point about 38 miles above Chattanooga and 151 miles below Knoxville.

In 1830 the State of Tennessee did some work looking to the improvement of this stream, but with little permanent benefit.

Under provisions of act of June 23, 1874, an examination and estimate of cost were made and submitted. (See Report of Chief of Engineers, 1875, page 809, *et seq.*)

This mountain stream was found to be greatly obstructed by rock-reefs, gravel-bars, snags, and overhanging trees.

It was originally projected, and without any important modifications forms the present project, to reduce the rock-reefs and gravel-bars, remove bowlders, snags, etc., and build wing-dams where necessary to contract the water-way, so as to secure a navigable channel of 40 feet wide and 2 feet deep at average low water to Savannah Ford, a distance of about 43 miles.

The original estimate of cost was, however, necessarily increased in 1885.

The following appropriations have been made for this improvement:

By act of—	
August 14, 1866	$10,000
June 18, 1878	10,000
March 3, 1879	3,000
June 14, 1880	3,000
March 3, 1881	1,500
August 2, 1882	1,500
July 5, 1884	2,500
August 5, 1886	2,500
August 11, 1888	1,000
Aggregating the sum of	35,000

This amount, less the appropriation by act of August 11, 1888, has been expended in carrying out the project as stated, and has resulted in securing an improved channel in the lower river, by the partial removal of surface obstructions and construction of wing-dams, which work was carried on during the last ten years only in a limited degree, by reason of the lack of sufficient funds for a radical improvement of the river.

Light-draught steam-boats ascend to Charleston, Tenn., about 21 miles, but the head of navigation for flat-boats and rafts is at Savannah Ford, about 22 miles above Charleston.

No work has been done during the fiscal year, the stage of water, etc., not being advantageous for the economical prosecution of the small amount of work that can be done with the funds available, $1,000.

The commerce of this river is increasing and consists largely of logs, grain, and general merchandise, the grain and other farm produce reaching a market on the flat and keel boats from the upper waters, and the general merchandise on the small steamers plying at intervals between Charleston and points on the Tennessee River.

The amount herein asked for ($1,500) can be profitably expended in continuing the work under the existing project.

Estimate of cost of improving Hiawassee River, Tennessee	$36,500.00
Amount appropriated	35,000.00
Amount expended	34,021.89

Money statement.

Amount appropriated by act of August 11, 1888	$1,000.00
July 1, 1889, outstanding liabilities	21.89
July 1, 1889, balance available	978.11
Amount (estimated) required for completion of existing project	1,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	1,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Commercial statistics, from July 1, 1888, to June 30, 1889.

Articles.	Quantities.	Articles.	Quantities.
Grain ..... bushels..	200,000	Logs ..... feet, B. M..	1,000,000
Live stock ..... head..	850	Merchandise ..... tons..	610
Hay ..... tons..	400		

C C 4.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

The Clinch River rises in the Cumberland Mountains, in southwestern Virginia, and after a course of about 395 miles enters the Tennessee River at Kingston, Tenn., 110 miles above Chattanooga. Its drainage area is about 1,436 square miles.

At intervals from 1830 to 1845 the State of Tennessee made appropriations for improving this water-way; but under the loose contract system adopted by the State no permanent benefit resulted. Some of the State dams have been repaired or modified by the United States, while others have been removed as obstructions.

Under provisions of the act of March 3, 1875, examinations both in Tennessee and Virginia were made in that year. (See Report of Chief of Engineers, 1876, page 741, *et seq.*)

It was then found that this river, in common with all the mountain streams tributary to the Tennessee, was obstructed by ledges and rock points, gravel shoals and bars, snags, overhanging trees, and a narrow, crooked channel at many places.

The project adopted, and under which operations are now carried on, is to reduce the rock-ledges and gravel-bars, and to remove snags, bowlders, and overhanging trees, and by the construction of riprap dams to contract the water-way, so as to obtain at ordinary low water a channel-depth of 2 feet from the mouth of river to Clinton, about 70 miles, and 1½ feet from Clinton to Walker's Ferry (Haynes), about 75 miles.

On the section of river above Haynes to the Tennessee State line, about 85 miles, the only work that can be done to advantage is to remove surface obstructions sufficiently to assist flat-boats and rafts during the so-called "rain-tides." The head of high-water navigation is at Osborn's Ford, Va., about 35 miles above the boundary line between Virginia and Tennessee.

The following appropriations have been made for this work, only its course in Tennessee, about 230 miles, being provided for by the six Congressional appropriations made for this stream:

Act of June 14, 1880	$10,000
Act of March 3, 1881	3,000
Act of August 2, 1882	3,000
Act of July 5, 1884	5,000
Act of August 5, 1886	5,000
Act of August 11, 1888	5,000
Aggregating the sum of	31,000

The amount expended to June 30, 1888, was $25,958.09, which has resulted in securing an improved channel at several of the principal obstructions in the lower river and safer navigation for flat-boats and rafts below Walker's Ferry (Haynes) at lower stages of the river than before channel work was begun in 1880.

During the present fiscal year high water hindered active operations until September 23, 1888, when work was begun in the channel and continued until the close of December, 1888. Inclement weather and high water again stopped the work until the middle of May, 1889, when work was resumed at Lew Allen Shoals and was in progress at close of fiscal year.

In September work was begun at Cane Creek—repairing and fitting up the boats, etc. The working force then moved down-stream about

1 mile to Kirkpatrick Shoals. At this point and at Moses Rock the rock ledges were reduced, and loose rock taken out, and the channel widened about 20 feet by blasting. Moving down-stream to Lew Allen Shoals, about 4 miles above Clinton, where one of the old dams built by the State was strengthened and raised about 3 feet, a new dam 120 feet long connecting the left bank with the island was also built, as well as a light dam to prevent a cutting through of the smaller island.

Owing to the probable shortness of the season two small parties were set at work clearing the channel of snags, drift, and other surface obstructions; one moving down the river from Walker's Ford and the other moving up-stream from Lew Allen Shoals, and adding 2 feet in height to the dam at Hibb's Shoal's.

On meeting, they dropped down to the main force at Lew Allen Shoals, where building riprap dams and rock excavation in channel were continued until work was closed for the season.

As soon as the stage of water permitted, in May, 1889, work was renewed at the Lew Allen Shoals, removing rock from channel and building dam at lower point of island, which operations were being carried on at the close of the fiscal year; the amount expended, including the outstanding liabilities, $4,275.82.

Location.	Rock excavation in channel.	Quarrying.		Riprap dam built.	Snag-boat.	
		Stripping.	Riprap.		Snags removed.	Trees cut up.
	Cu. yds.	*Cu. yds.*	*Cu. yds*	*Cu. yds.*	*No.*	*No.*
Kirkpatrick Shoals	5	.....	.....	.....	.....	.....
Moses Rock Shoals	50	.....	.....	.....	.....	.....
Hibb's Shoals	.....	.....	110	110	.....	.....
Lew Allen Shoals	.....	275	1,050	779	.....	.....
Snag-boat from Walker's Ford to Lew Allen Shoals	169	.....	.....	.....	5	8
Total	224	275	1,160	889	5	8

Attention is invited to the construction of fish trap dams in this stream, apparently authorized by the acts of Tennessee, forty-fourth general assembly, 1885, chapter 49, approved April 2, 1885.

These "traps" are formidable obstructions to the free use of these navigable waters, and appear to demand legislative or executive action to the extent of preventing the closure or obstruction of the navigable channel of the Clinch River. For copy of act above referred to, etc., see Report of Chief of Engineers, 1888, page 1608.

The Clinch River is the principal highway for the timber, ore, and products of the rich agricultural and mining sections drained by it and its tributary streams, there being no railroad readily accessible to the varied interests of its upper waters.

The commerce of the Clinch River is carried on principally in flatboats and rafts, which are floated on the "rain tides" or sudden rises to a market at Kingston or to Chattanooga and points on the Upper Tennessee. Small steamers ascend the Clinch to Clinton, about 70 miles. This commerce is reported as rapidly increasing, but it is very difficult to get data, "commercial statistics," the bulk of the freights going to make up the report of commerce of the Upper Tennessee, which is necessarily and largely the aggregate shipments of its upper tributaries, for instance. The rafting and lumber business of the Upper

Tennessee at and above Chattanooga receives its log supply to a great extent from the Clinch River.

The amount herein asked for—the balance of the estimates, $19,000—can be profitably expended in continuing the improvement of the principal obstructions by excavation and construction of wing-dams, and in clearing, widening, and deepening the channel between Walker's Ford (Haynes) and mouth of river, and in removing surface obstructions below the Virginia State line, as provided by the existing project; thus securing for the passage of rafts and flat-boats a lengthened season of navigation.

The original estimate for improving Clinch River, Tennessee	$26,400.00
Increased in 1885 to	50,000.00
Amount appropriated	31,000.00
Amount expended	30,163.07

Money statement.

July 1, 1888, amount available		$41.91
Amount appropriated by act of August 11, 1888		5,000.00
		5,041.91
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$3,589.98	
July 1, 1889, outstanding liabilities	615.00	
		4,204.98
July 1, 1889, balance available		836.93
Amount (estimated) required for completion of existing project		19,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		19,000 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Commercial statistics, from July 1, 1888, to June 30, 1889.

Articles.	Quantities.	Articles.	Quantities.
Grain ..... bushels..	185,000	Logs ..... feet B. M..	16,000,000
Lumber ..... feet B. M..	300,000	Merchandise ..... tons..	90

C C 5.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY.

This stream rises on the west slope of the Cumberland Mountains, in Kentucky, and after a winding course of about 700 miles enters the Ohio, about 73 miles above the mouth of that river.

Its improvement was undertaken by the States of Kentucky and Tennessee, together with other streams within their borders, in 1830 and subsequent years, but with only temporary beneficial results.

In 1830, Tennessee passed an act establishing a board of internal improvement, and appropriated $60,000 for the rivers lying west of Cumberland Mountains and east of Tennessee River, and in 1846 incorporated the "Cumberland Navigation Company," for the purpose of improving the "navigation of Cumberland River below the town of Nashville" by means of locks and dams, but it does not appear that

anything of moment was done under this franchise to furnish slack-water navigation upon the Lower Cumberland.

In 1834, a survey was ordered by Congress, and made by Capt. Howard Stanbury, upon which was based the project for the expenditure of the appropriations subsequently made.

From 1832 to 1838 Congress made five appropriations for this river, aggregating the sum of $155,000, of which sum $20,000 was specially applied below Nashville and $135,000 upon the general river.

No appropriations for its improvement were made by the United States from 1838 to 1871.

By act of July 11, 1870, an examination was authorized "at Cumberland River from its mouth to the head of navigation." (See Report of Chief of Engineers, 1871, page 469 *et seq.*) Upon this examination is based the present project for the improvement of the river below Nashville, also that for the work done since 1876 between Nashville and the foot of Smith's Shoals, until the adoption of the existing project for a complete system of locks and dams above Nashville to head of Smith's Shoals.

The work done at the Smith's Shoals, extending 10 miles above Burnside, Ky., was based on an examination made in 1875.

From 1871 to 1886, inclusive, thirteen appropriations have been made aggregating the sum of $886,000, which has been or is being applied upon the sections of the river, as specified and provided for by the several acts making the appropriations.

The obstructions in this river are of the same general character throughout its course, consisting of ledges, gravel and sand bars, bowlders, snags, overhanging trees, and rapid currents; and of mill-dams in the section of river above the mouth of Jellico Creek.

About 60 miles above Burnside, Ky., are the Great Falls of the Cumberland, a vast barrier to navigation, the difference of level between crest and foot of the main fall alone being about 54 feet.

A reconnaissance above the falls was made in 1880.

(1) BELOW NASHVILLE (ABOUT 200 MILES).

This section of the Cumberland is navigable from Nashville to the mouth of the river for all steamboats plying upon it for about six months in each year, and for boats drawing not more than 3 feet from six to eight months, and for boats of about 16 inches draught the entire year, except at an unusually low-water season, when the mouth of the river, at Smithland, Ky., is seriously obstructed by the formation of sand-bars, the volume of the Cumberland at that stage being insufficient, unaided, to effectually scour and keep open the Kentucky Chute of the Ohio to the deep waters of that river below Cumberland Island.

Explanatory of the work done and to be done, I repeat the statement in the annual report of last year.

From 1832 to the present time the work done below Nashville has been simply to clear the channel of surface obstructions, to improve from time to time some of the worst shoals, and thus to secure safety to the life and property afloat during a lengthened season of navigation; but as Congress has already provided for a radical improvement of the river above Nashville by a system of locks and dams, beginning with a lock at the lower Nashville Island, it may reasonably be anticipated that the section below Nashville will ultimately form a part of a complete system of canalization, to the advantage of navigation and the general interests of the Lower Cumberland, the river forming the highway, and in many cases the only means of transit for persons and property between the villages and towns scattered along its lower course.

Under provisions of act of August 11, 1888, a survey is to be made of the "Lower Cumberland River from Nashville to mouth to ascertain if necessary to establish locks and dams."

A survey party for this duty was organizing at the close of the fiscal year

The total amount appropriated for this section was $265,000, and the total amount expended to June 30, 1888, under the present project, was $254,858.35, which has resulted in removing surface obstructions, reducing gravel and sand bars, blasting a channel through reefs, and building riprap dams to contract the water-way sufficiently to obtain additional channel depth at the most dangerous obstructions, and a lengthened season of navigation.

No channel work has been done during the fiscal year, the stage of water being unfavorable since the appropriation of 1888 became available.

Amount expended during fiscal year, including outstanding liabilities, was $1,732.98. Forty-two bench-marks have been established to aid in determining uniform high-water grade lines on the lower Cumberland, in view of the probable construction of bridges by authority of Congress.

Watching and caring for engineer property and current contingent expenses for surveys, etc., formed part of the expenditures.

The difficulty of entering the mouth of the Cumberland River at low water, caused by the forming of shoals in the Kentucky Chute of the Ohio, was referred to a Board of Engineer Officers, who recommended the construction of a pile and brush dam, with crib superstructure, along the upper side of the tow-head and parallel to the south shore of Cumberland Island, and that the necessary bank protection be put in place before the dike is begun.

It is estimated that this work will cost about $130,000, to which has been added $20,000 for protecting bank of Cumberland Island in part.

With the report of the Board was transmitted an explanatory statement by the engineer officer in charge of the work of improving Cumberland River, having in view the making of the report more clear and complete, as a representation of the matter from the stand-point of the navigation and commercial interests of the Lower Cumberland.

This statement suggests that authoritative action be had establishing the exact locale of the mouth of the Cumberland, and also invites attention to the possible necessity of rebuilding the so-called Cumberland Dam, and closing the Dog Island Chute of the Ohio in order to give the needed relief at the mouth of the Cumberland.

No work has been done at the mouth of the river since 1884, but some advantage was obtained previously by dredging and construction of brush-dams; but the conditions now are practically what they were when work was begun in 1881, supplemented by the tendency to scour along the Kentucky shore and thus causing considerable caving of the left bank and consequent riparian damage.

In this connection the Paducah (Ky.) Standard reports in its River Bulletin of recent date "that the channel at the head of Cumberland Island is cutting out and it bids fair to become the regular channel again, as there is now over 5 feet of water there. When heretofore there was but 6 or 7 feet on the gauge at this place there was but scant 4 feet at the head of Cumberland Island. The channel above there is changing and the bank caving in and sending the water down through the old way."

The engineer officer in charge has not been able to examine into this

matter in season for this report, and can not therefore verify or deny the above statement.

The amount herein asked for ($200,000) can be profitably expended in continuing work under the present project, by removing snags, bowlders, etc., from the channel and reducing those obstructions which may be determined to be the most serious on examination; also to begin the improvement of the mouth of the river, by the construction of the proposed pile and brush dam, or dike, and bank revetment, provided the amount appropriated is in any reasonable degree adequate to commence the work.

The estimate of cost of improving Cumberland River below Nashville, as modified in 1888	$498,000.00
Amount appropriated	265,000.00
Amount expended	256,387.90

Money statement.

July 1, 1888, amount available		$141.65
Amount appropriated by act of August 11, 1888		10,000.00
		10,141.65
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$1,374.49	
July 1, 1889, outstanding liabilities	155.06	
		1,529.55
July 1, 1889, balance available		8,612.10

Amount (estimated) required for completion of existing project	233,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(2) ABOVE NASHVILLE 337 MILES—FROM NASHVILLE TO HEAD OF SMITH'S SHOALS.

The Cumberland River is navigable to Point Burnside, Kentucky, 327 miles, for steam-boats drawing not more than 3 feet from four to six months of each year, and for boats of greater draught from two to three months.

From Nashville to mouth of Caney Fork River (Carthage, 118 miles) the river is navigable for steam-boats of 2½ feet draught from six to eight months, and for those of greater draught four or five months. Steam-boats of light draught can ascend to Burksville, 238 miles above Nashville, for from five to seven months, and larger boats four or five months.

From 1876 to 1882, inclusive, the sum of $277,000 has been appropriated for this section, which has been expended in clearing the channel of snags, drift, and other surface obstructions, and in securing an increased depth of several inches at the principal obstructions, with a lengthened season of navigation.

A survey was made in 1883, and estimates and report submitted in 1884, providing for a complete system of locks and dams from Nashville to head of Smith's Shoals.

The act of July 5, 1884, appropriated $50,000 for an improvement to be made in accordance with the provisions of Senate Ex. Doc. 129, Forty-eighth Congress, first session, which provides that the locks "should be about 60 feet wide and 250 feet between miter-sills, though perhaps smaller dimensions would answer the purpose."

The present project embraces therefore the construction of 30 locks and dams, 23 locks from Nashville to Burnside, Ky., and 7 at Smith's Shoals, at an estimated cost of $4,077,922. (See Report of Chief of Engineers, 1884, page 1663 *et seq.*)

The number of locks estimated for between Nashville and Burnside can probably be lessened, as assuming the extreme lift of the locks to be 12 feet, the total fall of the river from Point Burnside to Nashville being 223 feet, the number of locks required may not exceed 20.

The following appropriations have been made for this work:

Act of July 5, 1884	$50,000
Act of August 5, 1886	75,000
Act of August 11, 1888	200,000
Aggregating the sum of	325,000

The first of the appropriations was largely expended in open channel-work, in a tentative manner, so as to ascertain how far wing and training dams could be used in combination with a system of lockage.

By act of August 5, 1886, Congress specifically provided for this work of canalization, appropriating $75,000 for "commencing with the lock at or near the lower island at Nashville."

Based on the report and recommendation of a Board of Engineer Officers, plans for the construction of this lock and dam (No. 1) have been approved. The dimensions of the lock being 280 feet long, 52 feet wide, having walls 26 feet high, with 4 feet of water on lower and 5 feet on upper miter-sill.

The amount expended to June 30, 1888, under the existing project was $54,424.20 and has been applied to clearing the channel, repairing dams, etc., and in making the necessary surveys, borings, current observations, estimates and general contingencies pertaining to the work of lock construction.

During the fiscal year lands were purchased by and conveyed to the United States for sites of lock and lock-keeper's house on the north bank, and site of dam-abutment on south bank of river. Contract was entered into September 19, 1888, with Holmes & Wilk, of Nashville, Tenn., for excavating lock-pit and part construction of lock-walls.

As soon as practicable work was begun under contract on the coffer-dam and excavating of lock-pit, but an unusually lengthened season of high water has prevented active operations, so very little progress has been made under this contract.

About 100 of the 800 linear feet of coffer-dam has been built, and 865 cubic yards of rock excavated from lock-pit; a small quantity of stone for lock masonry has also been quarried and cut.

In view of the fact that no building was available for use of the United States at the lock-site, it was deemed advisable to build the lock-keeper's house at once, so that it could be utilized for engineer office and store-house during the progress of lock and dam construction. This plan having been approved, contract was entered into November 9, 1888, with Phillip Lewis Hedrick, of Nashville, Tenn., to build the house, and it has been completed and accepted.

Plans were submitted and approved in May last showing the method of filling and emptying the chamber of Lock 1, and of maneuvering the gates and wickets by hydraulic machinery.

The plan for construction of abutment of Dam No. 1 having been approved, advertisements were issued, and bids for building the same will be opened August 6, 1889.

The necessary borings, soundings, test-levels, and current velocity

observations having been made above Lock No. 1, the proposed sites of Lock and Dam No. 2 and lock-keeper's house, near Beck's Ripple, about 14 miles above Nashville, have been approved by the Chief of Engineers, and negotiations for the purchase of the lands and examination as to title, were in progress at close of fiscal year. The lands will be obtained and contracts entered into for the construction of the lock, dam, and house as soon as possible to the extent of the funds available. A line of levels was also run from Lock 2 to head of Jones Island; the site of Lock 3 will probably be selected in that vicinity.

To expedite the cession of the jurisdiction of the State of Tennessee over said lands, and other lands needed for the same purposes within the limits of that State, so that work can be begun without delay awaiting action of the general assembly, which holds sessions only biennially, application was made to the Tennessee legislature last January for "an act to give consent to the purchase by the United States of such lands for sites of locks, dams, lock-keepers' houses, etc., as may be required in the improvement of the Cumberland River by the United States, and to grant cession of the jurisdiction over such lands;" such an act was approved by the governor of Tennessee January 26, 1889.

A serious break existing in the dam at Sand Shoals, about 150 miles above Nashville, it was repaired in January and February, and the alluvial bank in its vicinity protected by willow-brush and stone against further caving.

The interests of navigation demanding that the channel above Nashville should be kept clear of snags, overhanging trees, drift, etc., and that such repairs of dams be made as were absolutely necessary to maintain the improvements already secured, a snag-boat party was organized in March, and began operations by repairing the dam at Walton's Shoals, moving down-stream, clearing away surface obstructions, etc., to the mouth of Caney Fork River—a stretch of river of about 117 miles. The working force then moved up the Caney Fork River to do such work as could be done with the small amount of funds available for that work.

Location.	Quarrying riprap stone.	Repairing dams.				Protecting alluvial bank.		Snag-boat.	
		Spur riprap.	Logitudinal.	Willows placed in dams.	Earth placed on willows.	Brush.	Stone.	Snags removed.	Trees cut down.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cords.*	*Cu. yds.*	*Cords.*	*Cu. yds.*	*No.*	*No.*
Walton's Shoals	.....	263	65	10	20	.....	.....	.....	.....
Wilburn's Bar	.....	40	.....	.....	.....	.....	.....	.....	.....
Sand Shoals	42	123	.....	.....	.....	15	66	.....	.....
Snag-boat from Walton's Shoals to mouth of Caney Fork	.....	.....	.....	.....	.....	.....	.....	193	753
Total	42	426	65	10	20	15	66	193	753

Amount expended during the fiscal year, including outstanding liabilities, was $15,765.67.

In connection with the necessity of maintaining a safe, navigable, open river channel, during the period of lock construction, and that funds be appropriated for that purpose, I would respectfully recommend that the $5,000 appropriated by the act of August 2, 1882, for "improving Cumberland River, above the mouth of Jellico, Kentucky," and re-

maining in the United States Treasury undrawn, be made available for expenditure upon the "Cumberland River above Nashville," as it can be profitably expended removing surface obstructions, repairing dams, etc.

The commerce of the Upper Cumberland is shown, in part, by the accompanying statistics.

The prospective advantage to the commerce, as well as present benefits to the community, are the extension of the lower river trade to points above Nashville, as fast as the locks can be completed and utilized, and for the upper river the opening up of a cheap and safe means of transportation for the almost unlimited mineral and forest resources of the Upper Cumberland Valley.

A steam-boat line is operating between Burkesville and the head of navigation, Burnside, independent of the Nashville trade.

It is deemed advisable to repeat the recommendation of the last Annual Report:

That the section of river from Burnside to the Kentucky State line has claims for immediate improvement quite as great as those on the portion directly above Nashville.

The facilities for carrying on the improvement from Point Burnside are equal, if not superior, to those at Nashville.

Stone for locks, of excellent quality, can be found near at hand, while all other supplies, especially iron, can be obtained via Cincinnati rapidly and at the lowest possible cost.

These considerations lead to the suggestion that it may be advisable to subdivide the Cumberland River above Nashville to head of Smith's Shoals, Kentucky, and the appropriations for its improvement, into three sections:

	Miles.
First. In Tennessee, above Nashville	130
Second. In Kentucky, below Point Burnside	197
Third. At Smith's Shoals	10

The amount herein asked for ($1,000,000) can be profitably expended in completing lock and dam, and lock-house, No. 2; in making necessary survey of river and banks, from Lock 2 to Lock 3, to definitely determine the site of the latter; to purchase sites and enter into contracts for construction of lock and dam, and lock-house, No. 3; and if the plan above recommended to carry on work in two sections, the upper one being in Kentucky, be approved, to procure sites and begin the upper locks of the series below Smith's Shoals, about 4 miles below Burnside, Ky., near Waitsborough, to clear channel of snags, repair dams, and such miscellaneous work as may be necessary to maintain a safe, navigable, channel.

Estimates for improving Cumberland River from Nashville to head of Smith's Shoals		$4,077,922.00
Amount appropriated		325,000.00
Amount expended and amount covered by contracts	69,563.41 56,543.87	

Money statement.

July 1, 1888, amount available		$70,575.80
Amount appropriated by act of August 11, 1888		200,000.00
		270,575.80
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	13,746.01	
July 1, 1889, outstanding liabilities	1,393.20	
July 1, 1889, amount covered by existing contracts	56,543.87	
		71,683.08
July 1, 1889, balance available		198,892.72

Amount (estimated) required for completion of existing project $3,752,922.00
Amount that can be profitably expended in fiscal year ending June 30, 1891 ..... 1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for building coffer-dam, excavating lock-pit, and construction of Lock No. 1, Cumberland River, opened August 7, 1888, by Lieut. Col. J. W. Barlow, Corps of Engineers.

No.	Name and address of bidder.	Coffer-dam (600 linear feet).		Excavation, lock-pit.			
		Per linear foot.	Cost.	Earth deposit, if any, per cubic yard.	Natural rock in place, if any, per superficial foot.	Rock in place, 10,700 cubic yards, per cubic yard.	Cost.
1	Hughes & Gayner, Syracuse, N. Y.....	$8.00	$4,800	$0.40	$1.00	$1.90	$20,330
2	Hoag & Petitdidier, Pittsburgh, Pa ...	22.00	13,800	1.20	.27	3.49	37,343
3	H. F. Holmes & Phil. Wilk, jr., Nashville, Tenn.*	5.75	3,450	.50	.30	1.15	12,305
4	Whitsit & Adams, Nashville, Tenn....	8.00	4,800	.60	.30	1.60	17,120
5	D. McDonald, Louisville, Ky.....	15.00	9,000	.30	.40	1.20	12,840

No.	Name and address of bidder.	Lock construction, masonry.							Grand total cost.
		Backing, 2,500 cubic yards, per cubic yard.	Rock face, 600 cubic yards, per cubic yard.	Pointed face, 700 cubic yards, per cubic yard.	Bush hammered face, 300 cubic yards, per cubic yard.	Quoins, 40 cubic yards, per cubic yard.	Bolt-holes, 100 linear feet, per linear foot.	Cost.	
1	Hughes & Gayner, Syracuse, N. Y	$10.30	$15.50	$17.00	$22.00	$40	$0.75	$53,725	$80,855
2	Hoag & Petitdidier, Pittsburgh, Pa.....	9.00	13.00	15.00	17.00	.25	.67	49,867	101,010
3	H. F. Holmes & Phil. Wilk, jr., Nashville, Tenn.*	8.25	11.00	12.00	14.50	30	1.50	41,325	57,080
4	Whitsit & Adams, Nashville, Tenn	7.60	11.25	12.00	12.50	40	2.00	39,700	61,620
5	D. McDonald, Louisville, Ky	15.40 13.75	16.40 14.70	17.45	18.75	27	1.00	67,360	89,200

*Awarded.

Contract entered into with Holmes & Wilk, September 19, 1888, and in force at close of fiscal year.

Abstract of proposals for building one lock-keeper's house complete at Lock No. 1, Cumberland River, opened October 18, 1888, by Lieut. Col. J. W. Barlow, Corps of Engineers.

No.	Name and address of bidder.	Cost.	Remarks.
1	Phillip Lewis Hedrick, Nashville, Tenn.....	$2,740	*Awarded.

*Modified by supplemental agreement April 17, 1889, to $2,937.80.

Contract entered into with Phillip Lewis Hedrick, November 9, 1888.

COMMERCIAL STATISTICS.

Cumberland River below Nashville, from July 1, 1888, to June 30, 1889.

Articles.	Quantities.	Articles.	Quantities.
Flour.....barrels..	4,000	Tobacco.....tons..	7,000
Grain.....bushels..	200,000	Wood.....cords..	100,000
Hay.....tons..	200	Lumber.....feet, B. M..	2,000,000
Live-stock.....head..	4,000	Logs.....do...	7,000,000
Passengers.....number..	6,000	Sand.....cubic yards..	10,000
Salt.....barrels..	7,000	Merchandise.....tons..	8,000

Cumberland River above Nashville, from July 1, 1888, to June 30, 1889.

Articles.	Quantities.	Articles.	Quantities.
Flour.....barrels..	80,000	Passengers.....number..	15,000
Grain.....bushels..	500,000	Sand.....cubic yards..	50,000
Hay.....tons..	500	Salt.....barrels..	30,000
Iron.....do...	5,000	Tobacco.....tons..	5,000
Live-stock.....head..	3,000	Wood.....cords..	100,000
Lumber.....feet, B. M..	5,000,000	Merchandise.....tons..	7,000
Logs.....do....	25,000,000		

Cumberland River between Burnside and Burksville, Ky., from July 1, 1888, to June 30, 1889.

Articles.	Quantities.	Articles.	Quantities.
Coal.....tons..	318	Tobacco.....tons..	36
Flour.....barrels..	740	Lumber.....feet, B. M..	20,000
Grain.....bushels..	11,548	Spokes.....tons..	1,000
Live-stock.....head..	1,989	Staves.....do....	1,860
Salt.....barrels..	1,200	Merchandise.....do....	625

Steam-boats.

Names of boats.	Character.	Length.	Breadth.	Depth.	Tonnage.
City of Clarksville	Stern-wheel.	128	26	4	194
Cresent	....do.....	80	16	3	70
D. A. Goodin	....do.....	70	14	3	60

List of steam-boats plying on Cumberland River.

[Character: Stern-wheel.]

Names of boats.	Length.	Breadth.	Depth.	Tons.	Names of boats.	Length.	Breadth.	Depth.	Tons.
Below Nashville.					*Above Nashville.*				
J. P. Drouillard	163	31	5	467	Sam P. Jones	149	30	4	359
B. S. Rhea	162	32	5	303	John Fowler	149	30	4	237
T. Shiver	130	28	4	127	Matt. F. Allen	149	28	4	243
Julien Gracey	100	22	3	81	H. H. Bedford	149	27	4	139
J. T. Hillman	149	29	4	281	Crusader	146	22	3	186
R. G. Ragon	165	31	5	400	J. D. Carter	85	20	3	45
Jas. R. Skiles	100	22	3	41	Pearl	140	22	3	31
R. T. Holman	100	22	3	51	Wm. Porter	149	30	4	168

C C 6.

IMPROVEMENT OF SOUTH FORK OF CUMBERLAND RIVER, KENTUCKY.

This stream is formed by the junction, in Tennessee, of Clear Fork and New River, and after a northerly course of about 88 miles enters the Cumberland River near Burnside, Ky., about 2 miles below the Smith's Shoals.

Under the provisions of the act of June 14, 1880, an examination of this stream was made in 1881 (see Report of Chief of Engineers, 1881, page 1896, *et seq.*), and it was found to be greatly obstructed by immense sandstone bowlders in its upper course, which can only be removed at an enormous expense, while rock-reefs, bowlders, gravel-bars, etc., obstructed its lower waters.

The project adopted for the improvement of the channel was to reduce the gravel-bars and reefs, and build wing-dams to contract the water-way, so as to obtain a safe channel for the passage of rafts and flat-boats at stages of the river not less than 3 feet above low water, the work to be confined to the lower section of the river, from Devil's Jumps to the mouth, a distance of about 44 miles.

The following appropriations have been made for this work:

Act of August 2, 1882	$3,000
Act of July 5, 1884	4,000
Act of August 5, 1886	5,000

Aggregating the sum of $12,000, which has been expended in clearing and deepening the channel for about 16 miles above the mouth of the river; principally at Sloan's Shoals and Roberts' Mill Shoals.

No work was done during this fiscal year, the appropriation of 1886 being exhausted in September, 1887.

The commerce of this stream consists of logs in rafts, and occasionally of coal in flat-boats.

As stated in Annual Report for 1888, "The heavily timbered lands and immense coal-measures through which this river passes give abundant promise of a large river commerce when this stream offers a safe passage for rafts and flat-boats on the annual 'rain-tides.'"

The amount herein asked for ($15,000) can be profitably expended in continuing the work of improving the channel under the existing project.

Estimates for improving South Fork of Cumberland River, Kentucky.

From Kentucky line to Devil's Jumps	$27,538.00
From Devil's Jumps to mouth of river	35,265.00
Total for improvement in Kentucky	62,803.00
Amount appropriated	12,000.00
Amount expended	11,968.94

Money statement.

July 1, 1888, amount available	$31.06
July 1, 1889, balance available	31.06
Amount (estimated) required for completion of existing project	50,803.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics from July 1, 1888, to June 30, 1889.

Articles.	Quantities.
Coal.....tons..	500
Logs.....number..	12,193
Merchandise.....tons..	300

C C 7.

IMPROVEMENT OF CANEY FORK RIVER, TENNESSEE.

This stream flows wholly in the State of Tennessee. It rises in the Cumberland Mountains near Sparta, Tenn., and after a course of about 200 miles enters the Cumberland River at Carthage, Tenn., about 116 miles above Nashville.

The head of navigation is usually held to be at Sligo, Tenn., about 72 miles from mouth of river, but up-stream navigation can readily reach Frank's Ferry, about 20 miles above Sligo, when the latter point can be reached from the Cumberland River.

The State of Tennessee did some work in this stream, in view of its improvement, between 1830 and 1846, and in the vicinity of Frank's Ferry, in 1860.

Under the provisions of act of June 18, 1878, an examination was made early in 1879, from its mouth to Sligo Ford, about 72 miles. (See Report of Chief of Engineers, 1879, page 1275, *et seq.*)

This stream was found to have a very crooked channel, and to be obstructed by bowlders, gravel-bars, snags, and other surface obstructions.

By act of July 5, 1884, provision was made for the extension of the examination from Sligo to Frank's Ferry, about 20 miles. This was done in 1886. (See Report of Chief of Engineers, 1887, page 1768 *et seq.*) The obstructions were found to be similar in character to those in the lower 72 miles. The project adopted for the improvement of this 92 miles of river is to remove the surface obstructions, and to build the necessary wing-dams and training-walls, so as to obtain sufficient water for safe navigation for steam-boats drawing not more than 3 feet, during the usual boating season, about five months, from February to July.

The following appropriations have been made for this work:

Act of June 14, 1880	$6,000
Act of March 3, 1881	4,000
Act of August 2, 1882	4,000
Act of July 5, 1884	3,000
Act of August 5, 1886	3,000
Act of August 11, 1888	2,500
Aggregating the sum of	22,500

The amount expended to June 30, 1888, was $1,942.95, which was used in removing the snags, overhanging trees, etc., brought down by the annual floods, and in clearing the island-chutes of drift, etc., from Sligo to mouth of river; also in reducing the gravel and sand bars at the principal obstructions, and in repairing and extending the old riprap dams and building new ones where necessary.

This work has resulted in obtaining an improved channel to Sligo Ford when the water is at a 3-foot stage above ordinary low-water mark.

The appropriation by act of August 11, 1888, was made too late to take advantage of the low-water season of that year.

The stage of water and inclement weather, taken in connection with the small amount of funds available, prevented an economic and advantageous renewal of operations until near the close of the fiscal year.

Late in May a snagging party which had been employed clearing the channel of the Upper Cumberland River reached the mouth of the Caney Fork River,

This party being organized, it was deemed very advantageous to the latter stream that the cost of the fitting out of a special working force be avoided.

The steam snag-boat was therefore set to work clearing the channel of loose rock, snags, and overhanging trees, etc., from mouth of river to Chandler's Islands, about 5 miles. Above these islands, the channel was cleared during the working season of 1887.

Another small force was employed quarrying stone for and building riprap dams at Chandler's Islands for the purpose of changing the channel to the left of the lower island, thus avoiding the troublesome bar and sharp bend now encountered in crossing between the islands. Borings recently made in the gravel-bars show an absence of rock at the depth necessary to obtain this new channel.

A survey of the obstructions at Crousdale's Ferry was made during the month of June, and the dams necessary to improve the channel in this vicinity will be begun in July.

The amount expended during the fiscal year, including the outstanding indebtedness, was $1,054.72.

Location.	Excavating loose rock from channel.	Quarrying riprap stone.	Snag-boat.	
			Snags removed.	Trees cut up.
	Cu. yds.	*Cu. yds.*	*Number.*	*Number.*
Chandler's Island Chute	15	.....	.....	.....
Crousdale's Ferry	.....	600	.....	.....
Chandler's Island	.....	716	.....	.....
Snag-boat from Bluff Creek to foot of Snow Creek Island	.....	.....	28	221
Total	15	1,316	28	221

As stated in annual report for 1888, the Nashville and Knoxville Railroad Company wasted the excavated material from their "cuts" by throwing it into the river near the mouth of Bluff Creek.

The company have only partially removed these obstructions, but assurances have been made that all the rock thrown in by their contractors shall be satisfactorily disposed of during the next low water.

The commerce of the Caney Fork consists principally of agricultural produce and general merchandise; the river forming the principal highway through which the people of that section reach a market for sales or purchases. Some tobacco and a great many logs in rafts reach a market on the Cumberland River.

The character of this stream is such that a small annual outlay is necessary to maintain the channel in a safe, navigable condition, by clearing out the snags, drift, etc., brought down by the freshets.

The amount herein asked for, $10,000, can be profitably expended in snagging and removing loose rocks, etc., from the channel from Frank's Ferry to mouth of river, and in reducing gravel-bars and building wing-

dams, where necessary, at the principal obstructions in the lower river, as provided by the existing project.

The estimate for improving Caney Fork River, from its mouth to Frank's Ferry	$45,228.00
Amount appropriated	22,500.00
Amount expended	20,457.67

Money statement.

July 1, 1888, amount available		$578.05
Amount appropriated by act of August 11, 1888		2,500.00
		3,078.05
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$331.53	
July 1, 1889, outstanding liabilities	704.19	
		1,035.72
July 1, 1889, balance available		2,042.33
Amount (estimated) required for completion of existing project		22,729.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

APPENDIX D D.

IMPROVEMENT OF THE OHIO, MONONGAHELA, MUSKINGUM, AND ALLEGHENY RIVERS; OPERATING AND CARE OF DAVIS ISLAND LOCK AND DAM, OHIO RIVER; LOCK AND DAM NO. 9, MONONGAHELA RIVER, AND THE LOCKS AND DAMS ON THE MUSKINGUM RIVER, OHIO; CONSTRUCTION OF ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO, AND OF LOCK AND DAM AT HERR'S ISLAND, ALLEGHENY RIVER.

REPORT OF LIEUTENANT-COLONEL WILLIAM E. MERRILL, CORPS OF ENGINEERS, BVT. COL., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ohio River.
2. Operating and care of Davis Island Dam, Ohio River.
3. Monongahela River, West Virginia and Pennsylvania.
4. Operating and care of lock and dam No. 9, Monongahela River.
5. Allegheny River, Pennsylvania.
6. Dam at Herr's Island, Allegheny River.
7. Ice-harbor at mouth of Muskingum River, Ohio.
8. Muskingum River, Ohio.
9. Operating and care of the locks and dams on the Muskingum River, Ohio.

EXAMINATIONS.

10. Harbor at Owensborough, Kentucky.
11. Monongahela River above upper dam, West Virginia.
12. Cheat River, West Virginia.
13. Muskingum River, Ohio, from Zanesville to Dresden.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 1, 1889.

SIR: I have the honor to submit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1889.

First Lieuts. Lansing H. Beach and Cassius E. Gillette, Corps of Engineers, have been on duty under my direction throughout the fiscal year.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

D D 1.

IMPROVEMENT OF OHIO RIVER.

The act of Congress of August 11, 1888, contains the following paragraph:

Improving the Ohio River: Continuing improvement, $380,000, of which sum $25,000, or as much thereof as may be necessary, shall be expended in removing the rock obstruction at the mouth of Licking River; $20,000, or so much thereof as may be necessary, shall be expended for the construction of a drift-gap at Davis Island Dam, with the necessary bear-trap gates and masonry walls; and $7,500 in constructing an ice-

pier, pursuant to the present or prospective plan of the Chief of Engineers, at or near Portsmouth, Ohio: *Provided*, That the Secretary of War is hereby authorized and directed to obtain, if he can do so without cost to the United States, a perpetual lease or conveyance of the riparian rights of the property-owners at said locality in the event said ice-pier shall be located where there is no landing place: *And provided further*, That at said locality, if it be an improved landing, he shall first obtain a relinquishment of wharfage rights and dues in favor of water craft seeking protection from damage by ice, and no part of this appropriation shall be used for such purpose until the foregoing conditions are complied with; and $2,500 of said Ohio River appropriation may be used for improving the channel in the mouth of the Big Hocking River below the first dam therein; and $25,000 of said Ohio River appropriation may be used for harbor improvement at Madison, Ind., according to the plans heretofore submitted by Lieutenant Colonel Merrill, Corps of Engineers; also out of said Ohio River appropriation the sum of $15,000 may be expended in completing the construction of the embankment on the south side of the Great Miami River near its junction with the Ohio, to confine the waters of the Great Miami in great floods to the general course of its channel at or near the Ohio, to the end that the formation of the bar in the Ohio now obstructing navigation may be arrested; also out of said Ohio River appropriation the sum of $15,000 may be expended in the construction, or aiding in the construction, of such an embankment at Shawneetown, Ill., as will confine the waters of the river in great floods to the general course of its channel and protect the harbor; and $30,000 of said sum of $380,000 may be expended in protecting the harbor at Cairo, Ill., in the discretion of the Secretary of War, if in the opinion of the Secretary of War the interests of commerce require it.

During the year contracts were let for the construction of low crib dams between Davis and Neville islands and at the head of Mariette Island and of low guiding dikes at Eight Mile Island, Bonanza Bar, Madison, Ind., and Caseyville, Ky.

Drift-Gap at Davis Island Dam, 5 miles below Pittsburgh.—The construction of a drift-gap in this dam for the speedy passage of the great quantities of drift that come down from above was authorized in the last river and harbor act. The universal use of natural gas in and around Pittsburgh has put a stop to the usual destruction by fire of packing-boxes, straw, refuge from building operations, etc., and most of these materials are now thrown into the river and ultimately find their way to the Davis Island Dam, embarrassing the maneuvers by getting into culverts, and among wickets, trestles, and lock-gates. Such material can not well be passed over the dam, and the lowering of a wicket in low water is objectionable on account of the difficulty of raising it under the low-water head. The drift-gap consists of two parallel walls of masonry, between which is a bear-trap gate, closing a clear opening of 52 feet. This gate is handled by opening or closing valves, which control culverts built in the masonry walls and connecting with the space under the gates. With this device it is practicable to fill the bay above the bear-trap with drift, and flush it through by closing one valve and opening another. The advantage of this apparatus over any other is due to the fact that it can be lowered and raised by one man without special exertion and regardless of the head of water.

Work was begun on this drift-gap in the latter part of August, but the unusual and constant succession of rises which characterized the latter half of 1888 made it impossible to complete the work before winter. During the winter the ice came out of the Allegheny with such force that, in spite of protections of piling and riprap, about one-fourth of the coffer-dam was carried away. Work was resumed in the latter part of April, 1889, and was progressing favorably, when the flood of May 31, assisted by the breaking of the South Fork Reservoir, again broke down the coffer-dam and stopped work. As soon as the flood subsided work was resumed, and at the close of the fiscal year the débris had been cleared away, the damaged machinery had been repaired and replaced, and some progress made in rebuilding the coffer. For fur-

ther details reference is made to the report of Mr. Martin, which will be found under the heading of "Operating and care of the Davis Island Dam."

Dam between Davis and Neville islands, 5 miles below Pittsburgh.—The contract for this work was let on February 9, 1889, to Oliver Reed. Materials were gathered and preparations were made to commence construction, but owing to continued high water nothing further had been accomplished at the close of the fiscal year.

Dike at the trap, 11 miles below Pittsburgh.—During the winter of 1887-'88, 42 linear feet of paving and ballast was washed out from the lower slope of the shore end of this dike, and five timbers were carried away. These damages were thoroughly repaired in August, 1888. Experience has shown that it is quite difficult to hold the down-stream slopes of dams and of dikes which cross the current, even though these slopes are carefully paved. As an additional precaution I have adopted the rule of grouting all paving that has to be renewed, and this practice was followed at this locality. Thus far this has proved an effectual remedy.

Dam at Marietta Island, 168 miles below Pittsburgh.—The dam at this place, built in 1871–1873, had been so worn down by ice and drift as to be almost inoperative, and it was decided to renew the upper portion with crib-work and stone. A contract for this work was let on February 9, 1889, to Josiah T. Hart. Work was begun in May, but owing to continued high water work has thus far been limited to placing about 1,500 yards riprap stone.

Dike at Eight-Mile Island, 256 miles below Pittsburgh.—The object of this structure is to confine the waters at the foot of Eight-Mile Island so as to remove a bar which obstructs navigation at this point. A contract for this work was let on February 9, 1889, to John J. Shipman. Work was begun in May, but has been greatly hindered by high water. At the close of the fiscal year a large amount of material had been assembled for the dike, and the crib-work had been built for a distance of 150 feet from the shore end.

Dike at Bonanza Bar, 352 miles below Pittsburgh.—The object of this structure is to confine the waters at this locality, so as to remove a bar which of late years has been the worst in the stretch between the Great Kanawha and Cincinnati. A contract for this work was let on February 9, 1889, to John J. Shipman. Work was begun in May, but little progress could be made on account of continued high water. At the close of the fiscal year the dike had been partly completed for a length of 300 feet.

Dike at Madison, Ind., 552 miles below Pittsburgh.—This dike is to be built on the Kentucky shore, opposite the upper part of the city of Madison, and is intended to contract the water-way and force a current along the front of Madison so as to give deep water along the city wharf. Its construction was ordered in the river and harbor act of August 11, 1888. The contract for this work was let on February 9, 1889, to William Kirk. Work was begun in May, and at the close of the fiscal year the piling of the substructure had been driven for a distance of 200 feet from the shore and about 400 cords of brush weighted with stone had been placed in position. Further progress was impracticable on account of high water.

Dike at Caseyville, Ky., 860 miles below Pittsburgh.—Of late years the bar in front of this town has been unusually shoal, and it has frequently been shoaler than any other place between Evansville and Cairo. It is proposed to keep this channel on the Kentucky side by running out a guiding dike from the Highland Rocks on the Illinois shore opposite

Caseyville. A contract for this dike was let on February 9, 1889, to William Kirk. At the close of the fiscal year the work had been extended 150 feet from the shore, but not completed. Continued high water prevented further progress.

Dike at Middle of Grand Chain, 946 miles below Pittsburgh.—This is the middle one of the three dikes at the Grand Chain, and it is under construction under a contract with I. V. Hoag, jr., dated December 1, 1884. The locality is within the range of backwater from the Mississippi River, and, as work can only be prosecuted when both rivers are low, the contractor is subject to unusual obstacles and delays. This contract, which was to have been completed by December 31, 1885, has been several times extended, and now expires December 1, 1889. During the fiscal year the contractor was only able to work ten days, during which time the substructure was extended 69 feet to a total length of 1,943 feet, and the superstructure was extended 42 feet to a total length of 1,848 feet. The ultimate length of the dike will be 3,008 feet.

ICE-PIERS.

Ice-Pier at Pomeroy, 24 miles below Pittsburgh.—A contract to build this pier was made on the 19th of September, 1888, with John F. King, the contract expiring December 31, 1888. Owing to an unusual prevalence of high water in the autumn of 1888 the contract was extended at the contractor's request to September 1, 1889. At the close of the fiscal year the inner section of the pier had been completed, with the exception of the sheeting on the up-stream slope.

Ice-pier at Middleport, 250 miles below Pittsburgh.—A contract to build this pier was made on the 19th of September, 1888, with John F. King, the contract expiring December 31, 1888. Owing to an unusual prevalence of high water in the autumn of 1888, the contract was extended at the contractor's request to September 1, 1889. At the close of the fiscal year both sections of the pier had been raised to full height and completed, with the exception of the sheeting on the up-stream slope.

Ice-pier at Gallipolis, 267 miles below Pittsburgh.—A contract to build this pier was made on the 15th of September, 1888, with John C. Graham, the contract expiring December 31, 1888. Owing to an unusual prevalence of high water in the autumn of 1888, the contract was extended at the contractor's request to July 31, 1889. At the close of the fiscal year both sections of the pier had been built to full height and completed, with the exception of the sheeting on the up-stream slope.

Ice-pier at Ironton, 325 miles below Pittsburgh.—A contract to build this pier was made on the 21st of September, 1888, with John J. Shipman, the contract expiring December 31, 1888. The work was completed within the time named in the contract. The success of this contractor where the others failed was due to his greater experience and better methods of work.

The pier is built at the upper line of the city water-works, and consists of two sections, 36 feet apart, the inner section being about 20 feet further up-stream than the outer section. The tops are 21½ feet long and 24 feet wide. The sides and ends of the pier are vertical except the up-stream slope, which is inclined to the horizon at an angle of 50 degrees above low water. This up-stream slope is covered by 10-inch timber in juxtaposition, all of the other surfaces of the pier being half open. The top of the outer section is 31½ feet above low water, that of the inner section being 6 feet higher. The interiors of both sections are filled with riprap stone, and the top surfaces are paved.

For the convenience of water-craft, two large snubbing-posts extend above the top of the pier, and eight mooring-rings, at four different levels, afford convenient points for fastening lines.

The total amount of material in this ice-pier is as follows:

Oak timber	feet, B. M..	136,571
Iron drift-bolts	pounds..	16,386
Mooring rings and attachments	do....	2,045
Riprap stone	cubic yards..	3,033.6

Ice-pier at Portsmouth, Ohio.—There was considerable delay in getting this work under way on account of difference of opinion among the citizens of Portsmouth as to where it should be located, but they finally came to an agreement on the foot of Gay street, near the city waterworks, as the most desirable location, and as there was no engineering objection to this site it was adopted. As the law requires cession of riparian rights in favor of water-craft seeking shelter from ice, no contract for construction could be made until this cession had been made and approved by the Attorney-General of the United States. At the close of the fiscal year these necessary legal preliminaries had not been completed.

Rock obstruction at mouth of Licking River, 466 miles below Pittsburgh.—The sum of $25,000 from the appropriation for improving Ohio River was allotted by the river and harbor act of August 11, 1888, for continuing the removal of this obstruction. Proposals for this work were opened on June 20, 1889, and the contract was awarded to John F. King, of Belpre, Ohio, at $3.97½ per cubic yard.

Big Hocking River, 197 miles below Pittsburgh.—The allotment for work on this river could not be expended in 1888 on account of lack of time and unfavorable stages of water. It is proposed to prosecute the work by hired labor during the low-water season of 1889.

Great Miami embankment, 489 miles below Pittsburgh.—The river and harbor act of August 5, 1886, states that the object of this work is to confine the waters of the Great Miami in great floods "to the end that the formation of the bar in the Ohio River now forming and obstructing navigation may be arrested."

The embankment which the United States was expected to raise was so much of the Lawrenceburgh branch of the Cincinnati, Indianapolis, St. Louis and Chicago Railway as extends from Hardentown to the upper end of the Lawrenceburgh Fair Grounds. This contract has been completed, and the embankment in question has been raised to a height of 3 feet below the top of the great flood of 1884.

The additional allotment of $15,000 made in the last river and harbor act is to be expended in continuing this embankment along the lower line of the Fair Grounds to the Ohio and Mississippi Railway, where it crosses and continues on the southern side of this road and of the Cincinnati, Indianapolis, St. Louis and Chicago Railway to Elm street. As it is not practicable to carry the line across the track of the Ohio and Mississippi Railway, it is proposed to leave a gap at the crossing, provided with a masonry abutment on each side, arranged so that stop-planks can be used to close the gap during floods.

Embankment at Shawneetown, 848 miles below Pittsburgh.—This town is already protected by a levee, but it requires additional earth at some places, and the surfaces exposed to abrasion by waves must be paved. A contract for the necessary earth-work has been made with the Ohio and Mississippi Railway Company, at 20 cents per cubic yard, and the work of filling is in progress. At the close of the fiscal year about

8,600 cubic yards of earth had been placed on the levee. It is proposed to make a separate contract for the necessary paving.

Rock reef at Brooklyn, Ill., 923 miles below Pittsburgh.—This reef is what is left of the shoreward extension of the Brooklyn Rock, which was removed by the Ohio River dredges in 1884. Proposals for the removal of this reef were opened on the 20th of June, and the contract was awarded to Mr. H. S. Brown, at $1.10 per ton.

WORK OF DREDGES IN 1888.

During the first five months of 1888, and until June 12, the Ohio River dredges were at work on the Muskingum River, and their operations on this river were reported in my last annual report. While engaged on the Muskingum one of the dredges was called off for temporary work on the Ohio under the following circumstances:

On the 15th of March, 1888, four urgent telegrams were received at this office from the leading coal operators of Pittsburgh, stating that a large number of coal-barges had been wrecked in the Ohio River, at Brown's Island, 62 miles below Pittsburgh, and that navigation would be stopped until they were removed. I immediately telegraphed Mr. William Martin, engineer in charge of the Davis Island Dam, to go to Brown's Island and report the condition of affairs. He found 21 coal boats and barges stranded and scattered from the head to the foot of the island, leaving a clear channel of but 125 feet wide, which was totally inadequate for the passage of coal-fleets. The accident was due to the stranding in this narrow piece of river of a coal-tow, which was too deeply loaded, and to the inability of succeeding tows to pass it in safety. As the snag-boat was out of commission, I directed Mr. E. J. Carpenter to take one of the Ohio River dredges out of the Muskingum and proceed to Brown's Island. He selected the *Ohio*, and arrived with her at the scene of the wrecks on the 19th of March.

In clearing the channel it was necessary to destroy 6 coal-boats and 2 barges, using for this purpose the dipper, the wrecking-hook, or dynamite. Owing to the swift current the work was hazardous, but it was successfully accomplished at the cost of breaking the after-spud of the dredge, the socket of the wrecking-hook, and the anchor of the dredge tow-boat.

There were some other wrecks that could have been advantageously removed, although not seriously in the way of navigation, but the rapid rise of the river made it impossible to work on them; accordingly, on the 23d of March the *Ohio* started on her return to the Muskingum River, arriving at Marietta on the 24th.

The dredges quit work on the Muskingum on the 13th of June, and were laid up at Marietta until the 21st of July, when they started for Cincinnati to receive the customary annual repairs. These were completed in the latter part of September, and the *Oswego* started up the river on the 24th of that month, and the *Ohio* on the 26th.

Blennerhassett's Island, 188 miles below Pittsburgh.—The work proposed at this place was to remove the old half-moon dike on the Ohio shore, just below the foot of the island, together with the shore bar of cemented gravel on which it is built, and a projecting gravel-bar just above the dike. In order to carry off the spoil it was also necessary to make some cuts through a soft gravel-bar in mid-channel below the dike.

Work began on the 29th of September, and ended on the 16th of October, having been stopped by high water. During this time about

one-third of the half-moon dike was removed, and one cut was made through the channel-bar, the whole quantity of material handled being 15,189 cubic yards. Owing to the pressing necessity of work at Wheeling Creek Bar the dredges were sent to that place on October 24, without completing the work at Blennerhassett's Island.

Wheeling Creek Bar, 90 miles below Pittsburgh.—The work contemplated at this place was the removal of the enormous bar thrown out by Wheeling Creek during the extraordinary floods of July and August, 1888. The dredges arrived at Wheeling on the 25th and 27th of October, but the high stage of the river prevented them from beginning work until the 1st of November. The bar was found to consist of ashes, earth, bricks, stones, parts of bridges, and similar miscellaneous material, and to extend almost entirely across the river, the current at its outer end being so swift that a dredge could not be held in it by her spuds. The work was unusually difficult in character, and at some places one dredge had to remain idle and act as an anchorage for the one working in the swift water at the point of the bar. Constant rises in the river retarded the work, as did frequent breakages of machinery. Notwithstanding the difficulties and expense, it seemed essential to get this bar out of the way, and the dredges were retained there until this object was accomplished. Work finally ceased on the 15th of December, five days having been lost in October by high water and twenty days in November. Six cuts were made through the bar, and the channel was widened 175 feet, giving ample room for navigation and leaving space for a considerable amount of deposit from Wheeling Creek before dredging need be renewed. The total amount excavated was 28,852 cubic yards of miscellaneous material, 15½ tons of rock, and 1½ tons of bridge wreck.

Mouth of Muskingum River, 171 miles below Pittsburgh.—The dredges arrived here on the 16th of December, and on the 17th the *Oswego* excavated 1,051 cubic yards of earth and removed 5 logs with an aggregate weight of 3 tons. This work was done to obtain a safe harbor for winter. Both dredges then went into winter-quarters.

The following tabular statement gives the work done during the calendar year on the Ohio River and the expenditures for all purposes:

Dredges in commission, 1888.

Time at work:	Days.
Dredging gravel, etc	24
Dredging cemented gravel, etc	7½
Removing logs, rocks, etc	1½
Removing wrecks	2½
	35½
Time lost:	
Traveling	7½
Accidents	3
High water	27
Sundays	12
At work on Muskingum River	162
	211½
Total number of days	247
Total in commission in Ohio River	85

Work.

Gravel excavated per day of work, cubic yards	1,578.6
Gravel excavated during the season, cubic yards	37,886.0
Loose rock, etc., excavated per day of work, cubic yards	1,052.6
Loose rock, etc., excavated during the season, cubic yards	7,895.0
Total excavation during the season, cubic yards	45,781.0
Large rocks removed (number 6), tons	15.6
Logs removed (number 5), tons	3.0
Bridge pieces removed (number 2), tons	1.2
Coal-boat wrecks removed	8.0

Cost.

Equipment:	
Per day in commission	$7.69
Per day at work	25.57
For the season	907.64
Towing and fuel:	
Per day in commission	39.04
Per day at work	129.77
For the season	4,607.73
Repairs:	
Per day in commission	3.18
Per day at work	10.53
For the season	373.37
Salaries:	
Per day in commission	23.81
Per day at work	79.17
For the season	2,810.49
Total:	
Per day in commission	73.72
Per day of work	79.17
For the season	2,810.49

Dredges out of commission, 1888.

	Days.
Time:	
In ordinary	58
Annual repairs	60
Total	118
Cost:	
Salaries in ordinary	$720.00
Towing	350.00
Total in ordinary	1,070.00
Salaries during annual repairs	$1,495.72
Annual repairs	642.74
Total cost repairs	2,138.46
Total out of commission	3,108.46
Total per day out of commission	26.34
Total per day in ordinary	18.44

Cost of work, including all expenditures, in 1888.

Dredging gravel, etc.	$7,982.66
Dredging loose rock, cemented gravel, etc	2,494.60
Removing logs, rocks, etc	498.91
Wrecking	$831.52
Total expenditure	11,807.69

Cost per unit.

Per cubic yard of gravel, etc., excavated	$0.21 7/10
Per cubic yard of cemented gravel and loose rock	0.31 6/10
Per day in commission	$138.91
Per day of work	232.61

Statement of operations of dredges.

Date.	Miles below Pittsburgh.	Place.	Material removed.	Days of work.	Excavation.				Rocks and logs.	
					Gravel, etc.	Cemented gravel, loose rocks, etc.	Per day of work.	Per cubic yard.	No.	Weight.
1888.					*Cu. yds.*	*Cu. yds.*	*Cu. yds*	*Cents.*		*Tons.*
Mar.	62	Brown's Island	Wrecks*	2½	.....	.....	.....	.....	.....	.....
Sept.	188	Foot Blennerhassett's Island, at dike.	Cemented gravel	7½	.....	7,895.0	1,052.6	13.6	.....	.....
Sept.	188½	Foot Blennerhassett's Island, below dike.	Gravel	6	7,984.0	.....	1,330.7	.....	.....	.....
Nov.	90	Wheeling Creek Bar.	Gravel, etc	17½	28,851.5	.....	1,648.7	.....	.....	.....
Dec.										
Dec.	90	Wheeling Creek Bar.	Rocks, etc	1½	.....	.....	.....	.....	8	16.8
Dec.	171	Mouth Muskingum River.	Mud	1½	1,050.5	.....	2,101.0	11.1	5	3.0
		Total		35½	37,886.0	7,895.0	.....	.....	13	19.8

Place.	Expenditures.			
	Dredging gravel, etc.	Dredging cemented gravel, loose rocks, etc.	Rocks, logs, and wrecks.	Total for 1888.
Brown's Island	.....	.....	$831.52	$831.52
Foot Blennerhassett's Island, at dike	.....	$2,494.60	.....	2,494.60
Foot Blennerhassett's Island, below dike	$1,995.67	.....	.....	1,995.67
Wheeling Creek Bar	5,820.69	.....	.....	5,820.69
Wheeling Creek Bar	.....	.....	498.91	498.91
Mouth Muskingum River	166.30	.....	.....	166.30
Total	7,982.66	2,494.60	1,330.43	11,807.69

* Eight wrecks were removed.

WORK OF SNAG-BOAT IN 1888.

After undergoing her annual repairs, which were delayed by the late passage of the river and harbor act, the snag-boat *E. A. Woodruff* started on her annual cruise on the 13th of September. She ascended the river as far as the Davis Island Dam, 5 miles below Pittsburgh, and thence worked down-stream to Cincinnati, where she arrived on the 13th of October. The river was unusually high during the working season, and while working around Cincinnati it became evident that the amount of work that could be done in the Ohio River during the remainder of the season would not justify the cost of keeping the boat in commission. A constant succession of rises made it impossible to find the snags whose removal was desired, and negotiations were at once opened with various engineer officers to see if the boat could not be utilized on other rivers. Maj. A. M. Miller, Corps of Engineers, expressed a desire to use the *Woodruff* on the Mississippi, and, with the sanction of the Chief of Engineers, the snag-boat was temporarily placed under his command, at Cairo, on the 31st of October. The trip from Cincinnati to Cairo was made in daylight, and such snags as could be reached were removed en route.

The *Woodruff* remained under charge of Major Miller during the months of November, December, and January, having been returned by him at Cairo on the 31st of January, 1889. She came up the river at once, and went out of commission in Cincinnati on the 9th of February.

During the short period of service in the Ohio River she removed 329 snags, 1 rock, and 24 wrecks, and traveled 2,112 miles. While in service in the Mississippi she removed 376 snags and 10 wrecks, cut 2,199 trees, and traveled 1,886 miles.

The two largest snags pulled on the Ohio during the season weighed 56.3 tons and 53.8 tons, being much below the average of the heaviest snags, due to the fact that high water prevented work in the river below Louisville where the heaviest snags are usually found.

The heaviest work done on the Mississippi was the removing of the famous "Grand Tower" snag at Goose Island, which had long been a terror to navigation, and had caused two wrecks—that of the steam-boat from which it took its name, and of a barge loaded with railroad iron which lay on top of the snag when the *Woodruff* tackled it. To get the channel clear at this place required the full power of the boat and a week of continuous hard work.

STAGES OF THE OHIO RIVER DURING 1888–'89.

The summer and autumn of 1888 were remarkable for the long continuance of navigable water, being the exact opposite of the summer and autumn of 1887. The following tables show the navigable water at Pittsburgh, at Cincinnati, and at Evansville, the three stations which have been selected as giving the most reliable averages for the whole river.

Gauge at Davis Island Dam.—Owing to the fact that in low water the Davis Island Dam is up, and the Pittsburgh gauge shows a permanent reading of 6 feet, the actual depth for navigation in the open river below this dam must be obtained from the reading of the lower gauge on the lock at the dam. On this gauge a reading of 3 feet 2 inches corresponds to a navigable depth of 3 feet, and a reading of 6 feet corresponds to a navigable depth of 6 feet.

1888-'89.	Depth in channel.			Gauge-readings.	
	Under three feet.	Three feet and over.	Six feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
July	3	28	8	19.75	2.50
August	13	18	6	21.75	2.33
September	1	29	6	9.75	2.00
October	1	30	23	10.88	3.00
November	0	30	26	11.58	5.58
December	0	31	18	12.00	5.08
January	0	31	30	13.00	5.66
February	0	28	13	16.25	4.58
March	0	31	29	13.16	5.66
April	0	30	25	14.66	5.33
May	0	31	21	11.16	5.42
June	0	30	30	20.57	6.58
Total	18	347	235	21.75	2.33

Cincinnati gauge.—Gauge-readings of 4 feet correspond to about 3 feet in the channel, and gauge-readings of 7 feet correspond to about 6 feet in the channel.

1888-'89.	Depth in channel.			Gauge-readings.	
	Under three feet.	Three feet and over.	Six feet and over.	Highest.	Lowest
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
July	0	31	31	31.6	7.6
August	0	31	14	32.0	5.5
September	0	30	30	22.2	9.4
October	0	31	31	32.0	6.11
November	0	30	30	34.0	17.6
December	0	31	31	22.2	12.6
January	0	31	31	24.3	20.2
February	0	28	28	28.3	12.4
March	0	31	31	28.0	16.6
April	0	30	30	26.10	14.9
May	0	31	31	24.7	10.8
June	0	30	30	33.6	15.4
Total	0	365	348	38.3	5.5

Evansville gauge.—Gauge-readings of 2 feet correspond to about 3 feet in the channel, and gauge-readings of 6 feet correspond to about 6 feet in the channel.

1888-'89.	Depth in channel.			Gauge-readings.	
	Under three feet.	Three feet and over.	Six feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
July	0	31	22	21.8	4.9
August	0	31	14	25.0	3.3
September	0	30	30	20.6	6.5
October	0	31	21	21.1	4.3
November	0	30	30	31.9	17.6
December	0	31	31	16.4	9.0
January	0	31	31	25.4	12.0
February	0	28	28	29.2	11.3
March	0	31	31	20.3	12.5
April	0	30	30	18.6	10.2
May	0	31	31	16.2	7.6
June	0	30	30	27.1	10.9
Total	0	365	329	31.9	3.3

OPERATION OF DRAWS IN HIGH BRIDGES.

Owing to the fact that the river during the year 1888 did not at any time reach a flood stage, the draws in the Cincinnati Southern and the Kentucky and Indiana high bridges were not operated during the year.

Stoppage by ice.—Assuming, as heretofore, that the condition of affairs at Cincinnati is a fair average for the whole river, I have to report that during the past fiscal year there was no stoppage of navigation by ice.

ESTIMATE.

In my last annual report I included an estimate for the purchase of sites for two more movable dams. As the subject of the advisability of extending the system of movable dams on the river was referred by Congress to a Board of Engineer Officers, which reported in favor of extending the system begun at Davis Island at least as far as the mouth of the Beaver River, the estimate for the purchase of sites for these dams is renewed.

As navigation must necessarily be somewhat embarrassed during the construction of these works, and as several dams can be built at the the same time without adding to the embarrassment that will be caused by one, it would be better for navigation if work could be done simultaneously on all four of the movable dams recommended by the Board, but I have limited my estimate to two, in the belief that Congress would not be willing to undertake more at this present. The amount that is given is probably more than will be required for the mere purchase of sites, but the cost of the necessary land is a very uncertain quantity, and whatever surplus may remain will go into the work of construction.

The work of building submersible dikes and low dams across island chutes must necessarily continue, and estimates for this class of work are submitted.

Low dams and dikes	$500,000
Commencing movable dams 2 and 3	100,000
Rock bar across mouth of Licking River	50,000
Snagging	25,000
Dredging	19,000
Removing rock-reefs between Paducah and Cairo	50,000
Office, inspection, engineering, and contingencies	35,000
Total	779,000

Money statement.

July 1, 1888, amount available		$16,202.95
Amount appropriated by act of August 11, 1888		380,000.00
		396,202.95
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding and of amount covered by contracts July 1, 1888	$58,577.45	
July 1, 1889, outstanding liabilities	13,779.41	
July 1, 1889, amount covered by existing contracts	137,363.83	
		209,720.69
July 1, 1889, balance available		186,482.26
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		779,000.00

Abstract of contracts for improving Ohio River in force during the fiscal year ending June 30, 1889.

Contractors.	Improvement.	Date.	To expire—	Remarks.
Oliver Reed	Dike between Davis and Neville islands.	Feb. 9, 1889	Dec. 31, 1889	
Josiah T. Hart	Dam at head of Marietta Island.	....do	....do	
John J. Shipman	Dike at Eight Mile Island	....do	....do	
Do.	Dike at Bonanza Bar	....do	....do	
William Kirk	Dike at Madison, Ind	....do	....do	
Do.	Dike at Caseyville, Ky	....do	....do	
I. V. Hoag, jr	Dike at Grand Chain	Dec. 1, 1884	Dec. 31, 1885	Extended to December 1, 1889.
John F. King	Ice-piers at Pomeroy and Middleport, Ohio.	Sept. 19, 1888	Dec. 31, 1888	Extended to September 1, 1889.
John C. Graham	Ice-piers at Gallipolis, Ohio	Sept. 15, 1888	....do	Extended to July 31, 1889.
John J. Shipman	Ice-pier at Ironton, Ohio	Sept. 21, 1888	....do	Completed.
Cincinnati, Indianapolis, St. Louis and Chicago Railway Company.	Embankment on south side of Great Miami River.	Dec. 21, 1887	....do	Extended to June 1, 1889, and completed.
Ohio and Mississippi Railway Company.	Embankment at Shawneetown, Ill.	April 1, 1889	Sept. 30, 1889	
Stephen D. Davis	Tow-boat for service with dredges.	Sept. 19, 1888	Dec. 31, 1888	Completed.
Ella Layman Tow-boat Company.	.....do	June 11, 1889	Dec. 31, 1889	

Abstract of proposals for tow-boat for service with Ohio River dredges, opened September 10, 1888.

No.	Name and address of bidder.	Tow-boat.	Price per day.
1	S. D. Davis, Marietta, Ohio	J. H. McDonald	$45

Contract awarded to S. D. Davis, and executed under date of September 10, 1888.

Abstract of proposals for tow-boat for service with Ohio River dredges, opened May 27, 1889.

No.	Name and address of bidder.	Tow-boat.	Price per day.
1	John Shoup & Co., Pittsburgh, Pa	Geo. W. Stone	$33.00
2	Ella Layman Tow-boat Company, Charleston, W. Va	John R	33.00
3	Lewis Pope & Sons, New Matamoras, Ohio	H. M. Townsend	36.00
4	W. C. Jutte, Pittsburgh, Pa	Twilight	38.00
5	Lewis Pope & Sons, New Matamoras, Ohio	Champion No. 10	40.00
6	Fulton Tow-boat Company, Louisville, Ky	Little Andy Fulton	42.50
7	B. F. Wilson, Pittsburgh, Pa	John O. Phillips	43.00
8	S. D. Davis, Marietta, Ohio	J. H. McConnell	43.00
9	Kanawha and Ohio Tranafer Company, Charleston, W. Va.	Thos. W. Means	50.00

Contract awarded to Ella Layman Tow-boat Company, and executed under date of June 11, 1889.

Abstract of proposals for constructing dam between Davis and Neville islands, opened January 30, 1889.

No.	Name and address of bidder.	Oak timber, per M.	Hemlock timber, per M.	Drift-bolts, per pound.	Spikes, per pound.	Riprap stone, per cubic yard.	Paving, per square.	Total.
				Cents.	*Cents.*			
1	Oliver Reed, Water Cure, Pa	$26.00	$18.00	5	5	$1.25	$3.00	$6,761.25
2	I. V. Hoag, jr., Pittsburgh, Pa	25.00	19.00	8	8	1.50	1.90	7,111.45
3	A. W. McDonald, Coraopolis, Pa	27.50	21.50	4½	5	1.65	3.75	8,695.00

Contract awarded to Oliver Reed and executed under date of February 9, 1889.

Abstract of proposals for constructing dam at head of Marietta Island, opened January 30, 1889.

No.	Name and address of bidder.	Oak timber, per M.	Hemlock timber, per M.	Drift-bolts, per pound.	Spikes, per pound.	Riprap stone, per cubic yard.	Paving, per square.	Total.
				Cents.	*Cents.*			
4	Josiah T. Hart, Harmar, Ohio.	$23.50	$25.00	4	4	$0.89	$1.50	$8,629.40
5	Joshua R. King, Belpre, Ohio..	25.00	23.00	4	4	1.00	1.50	9,154.70
6	W. A. Snodgrass, Marietta, Ohio	25.00	25.00	2½	2½	1.00	2.70	9,401.95
2	I. V. Hoag, jr., Pittsburgh, Pa	25.00	19.00	3	3	1.50	1.90	10,926.90
3	A. W. McDonald, Coraopolis, Pa	26.00	21.00	4½	5	1.42	3.75	11,510.00

Contract awarded to Josiah T. Hart, and executed under date of February 9, 1889.

Abstract of proposals for constructing dike at Eight Mile Island, opened January 30, 1889.

No.	Name and address of bidder.	Oak timber, per M.	Hemlock timber, per M.	Drift-bolts, per pound.	Spikes, per pound.	Riprap stone, per cubic yard.	Paving, per square.	Total.
				Cents.	*Cents.*			
7	John J. Shipman, Washington, D. C	$17.00	$17.00	4	6	$0.78	$1.20	$14,978.00
8	C. A. Clenderine, Gallipolis, Ohio	21.00	21.00	5	5	.75	1.00	16,029.00
9	Frederick Hartweg, Dayton, Ky	21.00	21.00	3	5	.79	1.50	16,160.00
10	John F. King, Belpre, Ohio...	22.75	19.50	3½	5	.79	1.50	16,364.25
11	Graham & Gardner, Gallipolis, Ohio	21.50	21.50	3	3	.83½	1.00	16,666.00
5	Joshua R. King, Belpre, Ohio..	22.50	20.00	4	4	.87½	1.50	17,432.50
12	James R. Ware, Cincinnati, Ohio	23.00	22.50	5	6	.84	2.50	17,967.50
2	I. V. Hoag, jr., Pittsburgh, Pa.	23.00	19.00	3	3	1.25	1.90	21,390.00
4	Josiah T. Hart, Harmar, Ohio.	25.00	25.00	5	5	1.20	1.00	22,357.00
13	Stender Chaplen & Co., New Martinsville, W. Va	40.00	40.00	3½	3½	4.50	3.00	63,257.50

Contract awarded to John J. Shipman, and executed under date of February 9, 1889.

Abstract of proposals for constructing dike at Bonanza Bar, opened January 30, 1889.

No.	Name and address of bidder.	Oak timber, per M.	Hemlock timber, per M.	Drift-bolts, per pound.	Spikes, per pound.	Riprap stone, per cubic yard.	Paving, per square.	Total.
				Cents.	*Cents.*			
7	John J. Shipman, Washington, D. C	$17.00	$17.00	4	6	$0.78	$1.20	$16,868.80
14	Phillip H. Kelley, Portsmouth, Ohio	19.70	19.00	4	4	.79	3.00	18,351.00
9	Fred Hartweg, Dayton, Ky	21.00	21.00	3	5	.79	1.50	19,199.00
12	James R. Ware, Cincinnati, Ohio	22.50	22.00	5	6	.79	2.50	19,443.00
15	W. H. Wheeler & Co., Scioto-ville, Ohio	23.00	20.00	3½	5	.90	1.00	19,764.00
11	Graham & Gardner, Gallipolis, Ohio	23.00	23.00	3	3	.93	1.00	20,461.00
16	Richardson & Monroe, Portsmouth, Ohio	22.90	22.90	4½	5	.85	3.90	20,697.40
17	B. R. Morton, Newport, Ky	24.00	24.00	4	6	.90	5.60	22,088.40
5	Joshua R. King, Belpre, Ohio..	24.00	22.00	4	5	1.05	1.50	22,395.00
2	I. V. Hoag, jr., Pittsburgh, Pa..	23.00	19.00	3	3	1.25	1.90	24,094.60
18	William Strachan, Cincinnati, Ohio	28.00	26.00	4	4	1.48	2.50	29,396.00

Contract awarded to John J. Shipman, and executed under date of February 9, 1889.

Abstract of proposals for constructing dike at Madison, Ind., opened January 30, 1889.

No.	Name and address of bidder.	Piles, each.	Brush, per cord.	Oak plank, per M.	Drift-bolts, per pound.	Riprap stone, per cubic yard.	Total.
					Cents.		
19	William Kirk, Madison, Ind	$2.00	$0.85	$25.00	3	$0.85	$12,595.50
20	Henry C. Jones, Madison, Ind	2.15	1.20	23.00	6	.95	14,775.10
9	Fred Hartweg, Dayton, Ky	2.03	1.90	20.00	7	.84	17,617.32
12	James R. Ware, Cincinnati, Ohio	3.40	2.25	21.00	6	.81	17,848.10
7	John J. Shipman, Washington, D. C	2.50	2.00	25.00	8	.98	17,958.50
14	Phillip H. Kelley, Portsmouth, Ohio	5.00	1.50	22.00	8	1.00	18,573.50
17	B. R. Morton, Newport, Ky	3.80	2.00	42.00	16	.90	18,680.20
16	Richardson & Monroe, Portsmouth, Ohio	4.00	3.40	24.00	4½	.90	22,871.50
2	I. V. Hoag, jr., Pittsburgh, Pa	3.00	2.00	20.00	5	1.50	23,037.00

Contract awarded to William Kirk, and executed under date of February 9, 1889.

Abstract of proposals for constructing dike at Caseyville, Ky., opened January 30, 1889.

No.	Name and address of bidder.	Piles, each.	Brush, per cord.	Oak, plank per M.	Drift-bolts, per pound.	Riprap stone, per cubic yard.	Total.
					Cents.		
19	William Kirk, Madison, Ind	$2.50	$0.90	$25.00	3	$1.00	$25,453.00
21	Eigenmann & Hollerbach, Rockport, Ind	3.50	1.30	20.00	3	.80	25,799.00
22	Jacob Arnold & Co., Evansville, Ind	4.00	1.00	25.00	10	.85	25,943.00
9	Fred Hartweg, Dayton, Ky	2.00	1.90	20.00	7	.84	27,734.00
7	John J. Shipman, Washington, D. C	2.50	2.00	25.00	8	.98	31,421.00
12	James R. Ware, Cincinnati, Ohio	3.50	2.25	21.00	7	.93	33,331.20
23	H. S. Hopkins & Co., and Peter McGee, St. Louis, Mo.	2.50	2.40	22.00	4	.98	33,451.40
2	I. V. Hoag, jr., Pittsburgh, Pa	3.00	2.00	20.00	5	1.19	35,317.00
16	Richardson & Monroe, Portsmouth, Ohio	3.25	3.00	24.00	4½	.85	35,893.30
24	McGown & Kluge, Golconda, Ill	1.75	3.00	28.00	8	.98	36,015.10
25	Goulding & Appleby, New Albany, Ind	5.00	5.00	25.00	6	1.50	60,146.00

Contract awarded to William Kirk, and executed under date of February 9, 1889.

Abstract of proposals for completing embankment at Shawneetown, Ill.

No.	Bidder.	Earth filling, per cubic yard.	Total.
		Cents.	
1	Ohio and Mississippi Railway Company	20	$2,400

Contract awarded to the Ohio and Mississippi Railway Company, by authority of the Secretary of War, and executed under date of April 1, 1889.

Abstract of proposals for removing reef of rocks at Brooklyn, Ill.

No.	Name and address of bidder.	Price per ton.
1	H. S. Brown, Quincy, Ill	$1.10
2	Crescent City Wrecking Company, New Orleans, La	6.00
3	Bauer & Kluge, Golconda, Ill	7.00
4	I. V. Hoag, jr., Pittsburgh, Pa	12.75

Contract awarded to H. S. Brown, and executed under date of July 12, 1889.

Abstract of proposals for removing part of rock bar, at mouth of Licking River.

No.	Name and address of bidder.	By submarine blasting, per cubic yard.	By use of coffer dam, per cubic yard.
1	John F. King, Belpre, Ohio	.....	$3.97½
2	Fels & Joute, Cincinnati, Ohio	$4.25	4.50
3	Crescent City Wrecking Company, New Orleans, La	7.50	.....
4	Shipman & Richardson, Portsmouth, Ohio	.....	9.40
5	Kirchner & Scully, Cincinnati, Ohio	.....	9.50
6	Willard Johnson, Fulton, N. Y	9.50	10.00
7	I. V. Hoag, jr., Pittsburgh, Pa	12.75	14.70

Contract awarded to John F. King, and executed under date of July 12, 1889.

COMMERCIAL STATISTICS.

Coal shipments from Pittsburgh during the year ending June 30, 1889, prepared by Capt. William Evans.

Month.	To Cincinnati.					To Louisville.				
	Trips.	Coal boats.	Coal barges.	Fuel flats.	Bushels.	Trips.	Coal boats.	Coal barges.	Fuel flats.	Bushels.
1888.										
July	31	78	383	10	6,544,000	23	86	292	39	5,946,000
August	27	21	255	12	3,681,000	9	29	58	2	1,413,000
September	12	7	126	1	1,693,000	.....	.....	.....	.....	.....
October	41	12	445	14	6,126,000	36	57	405	15	6,536,000
November	20	20	228	1	3,406,000	24	99	177	28	5,103,000
December	12	13	180	14	1,966,000	14	45	121	15	2,775,000
1889.										
January	12	7	121	.....	1,671,000	9	52	26	.....	1,744,000
February	6	.....	64	2	812,000	10	64	44	4	2,174,000
March	36	45	365	1	5,884,000	53	305	374	56	10,883,000
April	25	23	262	6	3,937,000	42	178	293	30	8,418,000
May	4	.....	42	.....	530,000	5	6	64	.....	700,000
June	28	27	301	7	4,678,000	22	26	265	30	4,207,000
Total	264	253	2,622	68	40,948,000	257	947	2,119	219	50,099,000

Total number of bushels, 91,047,000.

Comparative table of bushels of coal shipped during the past six years.

Year.	To Cincinnati.	To Louisville.	Total.
1883–'84	27,439,000	38,491,000	65,930,000
1884–'85	40,560,000	27,275,000	67,835,000
1885–'86	34,457,000	52,236,000	86,693,000
1886–'87	32,165,000	51,827,000	83,902,000
1887–'88	28,193,000	36,740,000	64,933,000
1888–'89	40,948,000	50,099,000	91,047,000

Col. Sidney D. Maxwell, superintendent of the Cincinnati Chamber of Commerce, in his last annual report gives a full exhibit of the river commerce of Cincinnati, from which the following tables have been compiled:

River commerce of Cincinnati for the year ending August 31, 1889.

Articles.	Receipts.	Shipments.			Total.
		To New Orleans.	To other down-river ports.	To up-river ports.	
Ale and beer.....barrels..	.....	241	2,295	5,664	8,110
Apples.....do....	9,446	188	2,447	2,553	5,188
Beef.....pounds..	.....	1,760	16,063	770	18,593
Boots and shoes.....cases..	.....	31	6,654	6,206	12,891
Candles.....boxes..	.....	.....	653	205	858
Cattle.....head..	10,457	22	665	148	835
Cement.....barrels..	87,804	122	940	15,024	16,086
Chairs.....dozens..	.....	204	825	1,448	2,477
Coffee.....bags..	.....	33	6,769	8,599	15,401
Cooperage.....pieces..	.....	6,566	2,348	20	8,934
Corn.....bushels..	8,166	78	3,740	41,313	45,131
Cotton.....bales..	41,307	.....	712	1,383	2,095
Eggs.....packages..	30,601	.....	67	28	95
Flour.....barrels..	3,582	395	4,556	24,248	29,199
Fruit, dried.....pounds..	.....	8,109	33,880	156,405	198,395
Furniture.....packages..	.....	2,361	8,171	6,081	16,613
Glassware.....do....	.....	11,538	31,338	2,496	45,372
Hardware.....do....	.....	994	25,297	9,939	36,230
Hay.....bales..	17,173	1,053	141	3,019	4,213
Hog product.....pounds..	.....	29,605	767,705	2,956,292	3,753,602
Pork.....barrels..	.....	77	152	203	432
Hogs.....head..	87,928	.....	75	603	678
Iron.....tons..	14,928	1,190	3,542	540	5,272
Lead, white.....pounds..	.....	15,510	265,401	289,149	570,060
Lime.....barrels..	.....	.....	509	6,214	6,723
Manufactures.....pieces..	.....	1,002	619	1,098	2,719
Merchandise.....tons..	.....	1,709	7,392	6,487	15,568
Molasses.....barrels..	11,815	6	1,633	2,379	4,018
Nails.....kegs..	306,357	23,948	187,637	1,422	213,007
Oil.....barrels..	11,633	37	3,427	3,611	7,075
Peanuts.....bags..	7,395	.....	644	4,566	5,210
Petroleum.....barrels..	4,148	95	6,706	1,059	7,860
Potatoes.....barrels and sacks..	19,205	853	4,154	6,767	11,774
Rope and twine.....packages..	.....	376	6,555	1,815	8,746
Salt.....barrels..	105,410	235	44,663	1,251	56,149
Sheep.....head..	23,113	.....	128	21	144
Soap.....boxes..	.....	2,385	9,276	4,971	16,632
Sugar.....hogsheads..	94	.....	9	11	20
Sugar.....barrels..	9,315	.....	5,881	7,838	13,519
Tobacco.....hogsheads..	12,609	37	797	237	1,071
Tobacco.....cases, bundles, and packages..	.....	624	4,079	5,365	10,068
Vinegar.....barrels..	.....	538	1,857	2,932	5,327
Wheat.....bushels..	139,878	15	32	2,710	2,757
Whisky.....barrels..	41,917	577	7,651	4,860	13,088

The following tables, compiled from Colonel Maxwell's report, furnish some additional information regarding the steam-boat interests of Cincinnati:

Arrivals and departures of steam-boats at the port of Cincinnati.

Ports of departure and destination.	1882–'83.		1883–'84.		1884–'85.		1885–'86.		1886–'87.		1887–'88.	
	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.
From New Orleans.....	94	.....	63	.....	49	.....	63	.....	34	.....	35	.....
For New Orleans.....	.....	95	.....	70	.....	55	.....	66	.....	38	.....	37
From Pittsburgh.....	147	.....	114	.....	83	.....	103	.....	69	.....	156	.....
For Pittsburgh.....	.....	143	.....	111	.....	87	.....	103	.....	70	.....	153
From other ports.....	2,099	.....	1,993	.....	2,005	.....	2,323	.....	2,169	.....	1,389	.....
For other ports.....	.....	2,091	.....	1,981	.....	1,996	.....	2,314	.....	2,173	.....	1,385
Total.....	2,340	2,329	2,170	2,162	2,137	2,138	2,489	2,483	2,272	2,281	1,580	1,575

Steam-boats landing at Cincinnati.

Year.	No.	Tons.	Year.	No.	Tons.
1882–'83	217	75,344	1885–'86	196	63,998
1883–'84	198	68,312	1886–'87	168	53,616
1884–'85	205	65,261	1887–'88	151	50,612

Schedule of rates on flour per barrel by rail and river from Cincinnati for six years ending December 31, 1888.

Destination.	1883.		1884.		1885.	
	By rail.	By river.	By rail.	By river.	By rail.	By river.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Pittsburgh	26 to 31	25	18 to 31	20 to 25	22 to 26	20
Louisville	15 to 20	15 to 16	15	15	15	15
New Orleans	65	55	56 to 65	48 to 55	44 to 56	39 to 48

Destination.	1886.		1887.		1888.	
	By rail.	By river.	By rail.	By river.	By rail.	By river.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Pittsburgh	26 to 31	15 to 20	24 to 31	15	22 to 24	15
Louisville	15	15	15	15	15	15
New Orleans	44	35 to 39	44 to 49	35	40 to 49	35

I am indebted to Maj. Amos Stickney, U. S. Engineers, for the following statement of commerce passing the Falls of the Ohio, as recorded in the office of the Louisville and Portland Canal:

Commerce passing the Falls of the Ohio River by canal and by river.

Year.	Through canal.		Descending open river.		Ascending open river.		Total.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
1880–'81	4,196	1,124,836	1,220	377,055	503	140,306	5,919	1,642,199
1881–'82	3,964	904,343	1,793	537,906	750	220,965	6,507	1,663,214
1882–'83	4,954	1,226,455	1,294	398,240	179	61,802	6,427	1,686,497
1883–'84	4,346	1,070,650	1,384	432,575	301	98,757	6,031	1,602,982
1884–'85	4,886	1,217,231	708	231,695	95	24,320	5,689	1,473,246
1885–'86	5,057	1,254,342	1,296	408,619	393	102,536	6,726	1,765,497
1886–'87	4,768	1,157,250	1,793	991,974	667	290,507	7,228	2,439,731
1887–'88	5,471	1,315,851	1,514	863,237	361	137,230	7,346	2,316,318
1888–'89	6,838	1,815,985	893	383,081	102	37,850	7,833	2,236,917

For statistics of the commerce at the upper end of the river, reference is made to the report on operating and care of Davis Island Dam.

LETTER OF THE SECRETARY OF WAR.

WAR DEPARTMENT,
Washington City, January 16, 1889.

The Secretary of War has the honor to transmit to the House of Representatives a report of the Board of Engineers appointed in accordance with the requirements of the provisions of the river and harbor act of August 11, 1888, to examine the Ohio River below Pittsburgh as to the practicability of the improvement of the navigation of said river by means of movable dams, and the number of dams required.

The average number of days in each year during which the Ohio River is navigable for coal-boats drawing 6 feet of water is one hundred and fifty-five. Colonel Merrill having been called on to report how much the proposed improvement will prolong the period during which coal tows can be moved down the river, states that—

It may fairly be assumed that the four additional dams now proposed would give an average increase of available coal water of more than one month, with a possible maximum of three months.

It is reported that 64,933,000 bushels of coal were shipped from Pittsburgh during the fiscal year ending June 30, 1888. The value of this amount of coal at Cincinnati would be $4,545,310.

The increase in the capacity of the river for transportation of coal according to Colonel Merrill's estimate might amount to an average of two-fifths, or 25,973,200 bushels annually, worth at Cincinnati $1,818,124.

The estimated cost of the proposed improvement is $3,600,000. It will be observed that, unless there is a very great increase in the means for transportation of coal by boats and barges, the large expenditure proposed for the improvement of the river by movable dams would not be justified.

WM. C. ENDICOTT,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 6, 1888.

SIR: In obedience to the requirements of the provisions of the river and harbor act of August 11, 1888, viz:

The Secretary of War is authorized and directed to appoint a Board of three engineer officers of the United States Army, whose duty it shall be to thoroughly examine the Ohio River below Pittsburgh as to the practicability of the improvement of the navigation of said river by means of movable dams; and said Board shall report on or before the first Monday of December next, as to the feasibility and advisability of such project of improvement, the number of dams required, their location, with the cost of the same, together with the cost of maintaining them after the completion of the project. The Secretary of War shall transmit said report to Congress at its next session, together with the views of himself and the Chief of Engineers of the United States Army thereon.

I have the honor to submit the inclosed report of the Board of Engineers constituted to examine the subject, dated November 27, 1888.

It will be seen that the Board has made a full and careful study of the subject committed to it, and has prepared its report accordingly. After giving a clear and succinct description of the existing movable dam at Davis Island, and the improvements that experience in its management, etc., has dictated, it reaches the conclusion, for reasons fully shown, that "while it may be feasible to improve the Ohio River throughout its entire length by means of a slack-water system, it does not appear advisable to adopt such a system for the lower portion of the river, at least at the present time." * * * It "believes it practicable and desirable at the present time to extend the slack-water system of improvement on the Ohio to a point below the mouth of the Beaver River, 25 miles below Pittsburgh," and thinks "the use of mov-

able dams necessary in this stretch of the river, and justified by the experience already gained at the Davis Island Dam."

It recommends, accordingly, that dams be located approximately, as follows:

No. 2 at Merriman's Bar.
No. 3 at the Trap.
No. 4 near Economy.
No. 5 just below the mouth of the Beaver River.

These locations are not intended to be absolute, as there is usually an available margin of half a mile or so in locating a dam, and some latitude is necessary in order to protect the Government against excessive charges for the land required for lock and abutment.

The cost of the Davis Island lock and dam was $920,000, and assuming a probable economy of $20,000, the cost of the new dams can very fairly be taken at $900,000 each, or $3,600,000 for the four recommended.

The Board sums up its report by stating that it is "practicable, feasible, and advisable to improve the Ohio River from Pittsburgh to a point just below the mouth of the Beaver River, by the construction of movable dams, and that they will cost $3,600,000, as above stated, and that the annual cost of maintenance for each will be $6,500, or $26,000 for the four proposed."

The views of the Board are fully concurred in by this Department, and are commended to the favorable consideration of the Secretary of War.

Attention is respectfully invited to the map which accompanies the report of the Board.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

REPORT OF BOARD OF ENGINEERS.

The Board of Engineers constituted by Special Orders No. 41, paragraph 1, Headquarters Corps of Engineers, August 21, 1888, "to examine and report as to the practicability of improving the Ohio River below Pittsburgh by means of movable dams," met at Cincinnati, Ohio, September 3, 1888. On September 4 the Board made a personal examination of the movable dam at Davis Island, 5 miles below Pittsburgh, Pa., and on September 5, in accordance with previous notice, a public meeting was held in Pittsburgh, at which were present representatives of the coal and navigation interests of the Ohio River, who were invited to express their views on the subject committed to the consideration of the Board.

At this meeting it was the almost unanimous opinion of those present that the system of movable dams inaugurated at Davis Island should be extended.

On October 2 and 3 the Board made a personal examination of the movable dams on the Great Kanawha River.

Having considered all the information available upon the question presented, the Board has the honor to submit the following report:

The organization of the Board was in compliance with the requirements of an item in the river and harbor act of August 11, 1888, which provides as follows:

The Secretary of War is authorized and directed to appoint a Board of three engineer officers of the United States Army, whose duty it shall be to thoroughly examine the Ohio River below Pittsburgh, as to the practicability of the improvement of the

navigation of said river by means of movable dams, and said Board shall report on or before the first Monday of December next as to the feasibility and advisability of such project of improvement, the number of dams required, their location, with the cost of the same, together with the cost of maintaining them after the completion of the project.

This extract from the river and harbor act constitutes the instructions of the Board.

The question of the permanent improvement of the Ohio River has for many years received the consideration of the engineer officer in local charge, and many surveys have been made, including special surveys, with a view to the extension of the system of movable dams. The information furnished by these records being sufficiently full for the purposes of this investigation, further surveys were not deemed by the Board to be necessary at the present time.

The examination of the Davis Island Dam, and the information given by the representatives of the coal and navigation interests at the public meeting, show that this dam, by backing up the water in the harbor of Pittsburgh and furnishing a pool available during low water for use of the coal fleets, has served a most useful purpose, and has saved to the interest of navigation a very large sum of money, larger probably than the entire cost of the dam.

It was also made plain to the Board by the facts presented, that an extension of the system of improvement, which was inaugurated by the construction of the Davis Island Dam, is most desirable in order to prolong the period during which full coal tows can be moved down the river and empty ones can be returned to Pittsburgh. It was shown by a comparison of the gauge records at Pittsburgh and Wheeling, that a slackwater system of improvement from Pittsburgh to Wheeling would lengthen the time available for the movement of coal boats about two months, and both the gauge records and the evidence of the most experienced and interested transporters of coal show that a series of dams giving slackwater only to the mouth of the Beaver River, 25 miles below Pittsburgh, would furnish additional pools for the safe storage of coal fleets, would improve some of the worst localities, and would relieve coal navigation of many of the troubles now experienced.

The Davis Island movable dam was constructed, to a certain extent, as an experiment, but the success of such structures on European streams justified the belief that a similar one, with such modifications as experience might dictate, would be successful on the Ohio. It has been found, however, that a difference in local conditions has rendered the operation and maintenance of the Davis Island movable dam a more difficult task than seems to be the case with similar dams elsewhere, on account of the very sudden rises of the river, which frequently bring out immense quantities of drift and ice. This drift and ice sometimes comes so rapidly as to render the lowering of the wickets in advance of the flood a difficult matter, and sometimes it comes at a time when the safety of the dam must be risked in order to protect the coal fleets that are harbored in the pool above the dam. Arrangements are now being made for putting in a chute, through which drift and ice can be passed at times when it may be impracticable to lower the dam, and with this change, and the use on the weirs of the Chanoine method of tripping wickets, it is expected that the above-named difficulties will be overcome.

It ought to be mentioned that the Davis Island Dam is operated rapidly and easily at all other times, and the only hindrance to successful working at all times comes from ice and drift, both of which seem to prevail

in the Ohio River to a greater extent than in any other stream on which movable dams have been tried.

The practice of holding immense fleets of coal in the pool of the Davis Island Dam makes the service of this dam vastly more difficult than would be the case with others below it, as the fear of stranding and injuring coal-barges makes it necessary to keep the dam standing until the flood has actually reached it, and then the collection of drift or ice renders the operation of lowering it a difficult matter. Were there a series of dams below the one at Davis Island, coal could be moved downstream as it came from the Monongahela, the harbor would no longer be crowded with coal-barges, and there would be nothing to prevent the dam from being lowered in time to avoid the packing of drift or ice, and when it could be done with safety and dispatch.

It is always easy to lower or raise a movable dam in low water, and difficulty and danger only appear when the dam is kept up too long, and has to be lowered in the face of a rapidly rising river.

Under the most favorable conditions a movable dam is a somewhat complicated structure, requiring constant care and attention, and its use, to produce slackwater, does not appear advisable in any case where a fixed dam can be made to give the requisite facilities to navigation. Unfortunately there are many rivers on which the use of fixed dams is wholly inadmissible, and this is certainly true of the upper part of the Ohio, as locks even of extraordinary dimensions can not furnish adequate accommodation to descending coal fleets, and dams that can be lowered and got out of the way are a necessity.

While it may be feasible to improve the Ohio River throughout its entire length by means of a slackwater system it does not appear advisable to adopt such a system for the lower portion of the river, at least at the present time. On a large portion of the stream it is most probable that an open-channel improvement will furnish all the relief necessary to the interests of commerce, or all that may be required for many years to come. This system of open-channel improvement should be adopted whenever practicable, both on account of its smaller first cost and cost of maintenance, and its greater convenience to navigation.

The Board is decidedly of the opinion that the end has not yet been reached in the construction of movable dams, as is clearly shown by the fact that although the Davis Island Dam was built with all the latest improvements known at the time, important changes are now in progress which have been demanded by practical experience in order to better adapt it to the conditions of the Ohio River.

It would therefore appear desirable that the extending of the system of movable dams, even to the portion of the Ohio to which they are specially adapted, and on which they appear to be a necessity, should be gradual. On the other hand it is undesirable, and in fact impracticable, to prepare detailed projects for any more of such work than can be carried out in the immediate future, and the preparation of further plans and projects should be postponed to such time as will permit the utilization of the experience that will be gained as the work progresses.

It does not seem wise at this present to even attempt to define the limits of the region that should ultimately be improved by movable dams, as it will take long years to build those that the Board feels justified in recommending, and the experience acquired with these will enable a future Board to act on such questions with a certainty that the present Board can not possibly have.

The Board believes it practicable and desirable at the present time to extend the slack-water system of improvement on the Ohio to a point

below the mouth of the Beaver River 25 miles below Pittsburgh, and believes the use of movable dams necessary on this stretch of river a justified by the experience already gained at the Davis Island Dam. is assumed in this conclusion that by the time the construction of t additional dams can be undertaken such further experience will ha been gained at Davis Island as will result in obviating the troubles n resulting from drift and ice, and in this connection it is proper to mark that at none of the locations where the additional dams are reco mended will the obstructive and destructive effect of ice and drift be great as at Davis Island.

It is unadvisable to make detailed plans at this present, nor can they be prepared in the limited time allowed for this report. The general type of dam is all that a Board can be expected to determine, and the utmost latitude should be allowed to the local engineer to adopt every improvement from every available source, subject, of course, to the approval of the Chief of Engineers.

The heights above mean ocean level heretofore used on the upper end of the Ohio River have depended on the accuracy of the determination of a certain bench at the Union Depot in Pittsburgh. Within the last year the Pennsylvania Railroad has releveled its road-bed with great care, and the result shows that the height of the Union Depot bench above mean ocean level is 2.16 feet less than heretofore assumed. This change has necessitated a corresponding change in the Ohio River levels, and those used in this report have been made to conform to the new determination.

According to present experience it is not practicable to handle wickets that have a vertical height of over 13 feet, and if we assume a 6-foot navigation, it follows that the lift between pools will be 7 feet, and that the elevations of the sills of the navigable passes will decrease by 7 feet as we descend the river.

As the sill of the navigable pass of the Davis Island Dam is at elevation 690.84, the sills of the dams that follow must be at the following elevations:

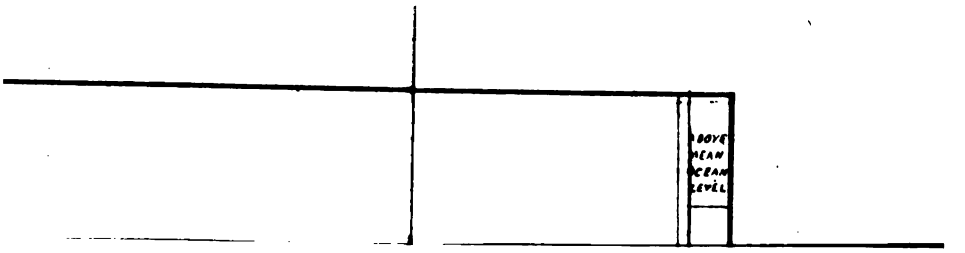
	Feet
No. 2	683.84
No. 3	676.84
No. 4	669.84
No. 5	662.84

They must therefore be located at points where the bed of the river is at these elevations, on the assumption that the bed is in a line parallel to the low-water line and at a depth below it equal to the navigable depth in low water. The approximate localities for these dams will therefore be as follows:

No. 2, at Merriman Bar.
No. 3, at The Trap.
No. 4, near Economy.
No. 5, just below the mouth of Beaver River.

These locations are not intended to be absolute, as there is usually an available margin of half a mile or so in locating a dam, and some latitude is necessary in order to protect the Government against excessive charges for the land required for lock and abutment.

The cost of the Davis Island Lock and Dam was $920,000, and assuming a probable economy of $20,000, the cost of the new dams can very fairly be taken at $900,000 each, or $3,600,000 for the four recommended.



The annual cost of operating will be about $6,500 for each dam.

Referring again to the item in the river and harbor act providing for the organization of this Board, the Board would sum up the whole matter by stating that it is "practicable, feasible, and advisable" to improve the Ohio River from Pittsburgh to a point just below the mouth of the Beaver River, a distance of about 25 miles, by the construction of movable dams; that four additional dams will be required; that they will cost $3,600,000; and that the annual cost of maintenance will be $26,000.

For the portion of the Ohio River below the point near the mouth of Beaver River selected for a dam, the Board is not prepared to recommend an extension of the system of movable dams, believing that the subject should be reserved for future consideration.

Accompanying this report will be found a profile of the Ohio River from Pittsburgh to Wheeling, on which are shown the four movable dams whose construction has been recommended by the Board. Tracings of sites for movable dams from Pittsburgh to Wheeling were forwarded May 20, 1879, by Maj. W. E. Merrill, Corps of Engineers, and reference is made to these tracings to show that eligible sites for movable dams can be acquired without difficulty at any point where these constructions may be desired. At no point within the distance named can a rock bottom be found, and therefore there is no marked difference between any of the sites that may be chosen.

Wherever we may build we must build on gravel, but the fact that the Davis Island Dam has been successfully built on this material proves that this fact is no obstacle to successful construction.

WM. E. MERRILL,
Lieut. Col. of Engineers.
AMOS STICKNEY,
Major of Engineers, U. S. A.
A. MACKENZIE,
Major of Engineers, U. S. A.

D D 2.

OPERATING AND CARE OF DAVIS ISLAND DAM, OHIO RIVER.

Mr. William Martin, chief engineer, has continued in local charge during the past year, and has performed his important and difficult duties with his customary efficiency and skill.

At the beginning of the fiscal year the dam was standing, and during the year it was handled as follows:

Lowered dam July 9–10.
Raised dam July 23–28.
Lowered dam August 19–21.
Raised dam September 8.
Lowered dam September 10.
Raised dam September 16–17.
Lowered dam October 8.

And thereafter the dam remained down to the close of the fiscal year.

The constant succession of rises in the autumn of 1888 made it necessaay to handle the dam frequently, but this was done without accident or difficulty. After the last lowering the dam was left down in order to build the gap for the passage of drift, but the continuance of

rises made the raising of the dam unnecessary, although, unfortunately, at the same time it prevented the completion of the drift-gap. The report on the latter structure will be found in the report on the Ohio River.

On the 9th of July the dam was lowered in the face of a tremendous flood out of the Monongahela, and during the lowering the drift accumulated to such an extent above the bridges of Weirs 2 and 3 (Weir 1 bridge was carried away in 1887) as to stand from 5 to 10 feet above the floor of the bridges. As a result of this pressure the bridge of Weir 2 gave way and was destroyed. The dam proper was not injured, and it was raised two weeks afterwards, as soon as the water fell low enough to make it necessary.

It is worthy of note that about one hundred coal barges were lost during this flood, all of which had been lying in the pools of the Monongahela River, and that there were no casualties to the coal fleets that were in the pool of the Davis Island Dam, many of which passed down the river before the flood reached its maximum, which would have been impossible before the Davis Island Dam was built. I have been told by prominent coal operators that in this one experience the dam saved more than its original cost. I do not guaranty the accuracy of this esmate, but the main fact that the dam proved a great benefit to coal-shippers is beyond question.

In my last annual report I recommended the insertion of Chanoine trippers, in order to be able to drop the weirs in times of heavy drifts and ice, which can not now be done satisfactorily, as the weir-wickets are handled from the service-bridge, and the opening of the weirs draws the ice and drift against the bridge, and makes it impossible to lower it. We have already lost the bridges of Weirs 1 and 2 from this cause, and as the cause itself could not be removed, and as the dam could be raised and lowered without the use of service-bridges, those that were destroyed have not been rebuilt.

After designing several trippers for use on the weirs, I become dissatisfied with this method of working the weir-wickets, on account of the difficulty of guarding against the heavy deposits of gravel which are known to accumulate on the weirs when the dam is down, and also on account of the great cost of changing the structure so as to adapt it to the use of trippers. I finally concluded that the dam could be safely and easily dropped by placing the maneuvering boat on the lower side of the line of wickets and pushing the wickets up-stream until the props dropped off of their seats, using a push-bar, worked by our present machinery. The advantages of this method of working are very great; it is inexpensive, it makes bridges unnecessary, it places the boat where it is sheltered from ice and drift, it enables the crew to see that the space below a wicket is free from logs before the wicket is dropped, and it provides a safe method of handling the pass as well as the weirs. There seems to be no reasonable doubt of the success of the device, and accordingly apparatus has been built and attached to the maneuvering boat. As the dam has been down since October there has been no opportunity to test it as yet. If its success is as great as is anticipated the problem of handling large movable dams in rivers that are obstructed by ice and drift will have been solved.

There is never any difficulty in raising a movable dam from a maneuvering-boat placed above it, as at that time there is neither ice nor drift to interfere; the difficulty hitherto has been in lowering the dam in the face of a rise bringing with it large quantities of drift and ice.

During the year the lock in all of its details has worked very satisfac-

torily. The insertion of spring tug-links in the operating chains has been a decided improvement. The lock-gate engines have been housed and new decks have been put on the gate recesses.

In the dam a few of the defective steel cross-heads have been replaced by wrought-iron ones, and the present proportion is 71 of the former to 68 of the latter. The scour below the dam still needs attention, and it is proposed to drive piling among the riprap in order to break the force of the overfall.

For further details reference is made to the annexed report of Mr. William Martin, the resident engineer.

The following table shows the commerce passing the dam during three years ending June 30, 1889:

Vessels passing the Davis Island Dam.	1886-'87.		1887-'88.		1888-'89.	
	Through navigable pass.	Through lock.	Through navigable pass.	Through lock.	Through navigable pass.	Through lock.
Passenger boats	414	55	336	36	687	26
Freight boats	83	9	34	9	134	2
Tow-boats	3,385	590	2,446	549	3,644	141
Model barges	306	14	121	.....	211	2
Coal boats	1,520	42	1,752	100	1,811	77
Coal barges	8,141	451	6,322	352	8,520	356
Coal flats	3,320	667	1,947	757	3,545	216
Rafts	53	7	56	7	93	4
Miscellaneous craft	95	67	50	61	184	12
Total	17,317	1,902	13,064	1,871	18,829	836
Number of lockages	.....	572	.....	712	.....	352

Detailed statement of expenses incurred at the Davis Island Dam, Ohio River, during the fiscal year ending June 30, 1889.

Month.	Office and general administration.					Tools and appliances.	Repairs.				Grand total.
	Salaries.	Supplies.	Maps and drawings.	Miscellaneous expenses.	Total.		Labor.	Materials.	Under contract.	Total.	
1888.											
July	.....	.....	.....	$52.88	$52.88	.....	.....	.....	.....	.....	$52.88
Aug.	$1,280.00	.....	$83.33	83.86	1,397.19	$76.59	$394.29	.....	.....	$391.20	1,868.07
Sept.	.....	$15.05	.....	15.95	31.00	4.65	.....	$2,034.00	.....	2,034.00	2,069.65
Oct.	630.00	.....	.....	18.00	648.00	135.33	.....	.....	.....	.....	783.33
Nov.	615.00	27.25	.....	93.40	735.65	147.48	.....	1,372.73	.....	1,372.73	2,255.86
Dec.	581.67	.....	375.83	63.08	1,020.58	.70	.....	259.73	$334.58	594.31	1,615.59
1889.											
Jan.	495.00	2.50	175.00	31.05	703.55	.....	.....	.....	.....	.....	703.55
Feb.	615.00	17.82	175.00	120.00	927.82	7.20	.....	368.46	38.17	406.63	1,341.65
Mar.	615.00	206.66	58.33	5.26	885.25	30.93	.....	8.30	79.68	87.98	1,004.16
Apr.	615.00	.....	.....	52.88	667.88	3.00	.....	188.95	2.00	190.95	861.83
May	606.67	100.52	.....	.60	707.79	17.85	.....	472.12	.....	472.12	1,197.76
June	566.50	.....	.....	.....	566.50	13.03	.....	.....	13.87	13.87	593.40
Totals.	6,569.84	369.80	867.49	536.96	8,344.09	436.76	394.29	4,704.29	468.30	5,566.88	14,347.73

Estimate for fiscal year ending June 30, 1890.

Salaries	$7,500
Gauge reports	400
Telephone	240
Natural gas, for fuel and light	350
Oil, lines, and other supplies	500
Diver	50
Diver's dress	40
Riprap protection below dam	3,000
Breech weight for wickets for navigable pass	80
Repair of quarters on Davis Island	300
Repair of stone steps of lock-keeper's house	150
Post-office box	6
Contingencies	1,000
Total	13,61

REPORT OF WILLIAM MARTIN, ASSISTANT ENGINEER.

LOCK.

Terre-plein of lock.—The terre-plein within the land wall inclosure which was sown with grass-seed last year had begun to assume an attractive appearance, but the rain-storm on the night of the 10th of May washed down some of the railroad embankment, depositing the débris on the terre-plein and destroying the grass.

To attempt a remedy would be useless until the question of property line between the United States and the Pittsburg, Fort Wayne and Chicago Railway has been settled, because any work of a permanent character might be forfeited by us in the settlement of the dispute.

Lock-gates.—The lock-gates continue to work satisfactorily, no trouble having arisen from any cause. Flexible gate-chain connections, for relieving the initial strain on the chains, were attached to each gate, one at each end. A trial test was made with very satisfactory results.

New timber-decks were constructed over the gate recesses. These decks were necessary to keep out the débris which is washed over the railroad embankment by heavy rains. Hatches are constructed in the decks for access to the gates in making repairs, for cleaning out débris from the recesses, and for ventilation.

Lock-gate engine-houses.—Houses for protecting the lock-gate engines from the weather were constructed, one at each lock-gate. As the engines are so arranged that they can be moved to the rear of the lock-gate recesses at times of floods, it was necessary to make the houses so that they could be removed from the engines as quickly as possible. The roof and supporting stanchions of each house are made of iron, the stanchions being fastened to the bed-plates. The sides and ends are composed of wooden batten doors, detachable for ventilation, and to allow of the engines being moved. The roof and its supports are carried along with the engines.

Lower guide-wall.—I would now renew my recommendation that the guiding crib below the lock be extended. The crib is now 250 feet long, but this length is insufficient for the easy entrance to the lock of long tows. The eddy caused by the lock and the lower gate recess creates so great an inset of the current towards the guiding crib as to bind boats against it, thus making their entrance to the lock very difficult. The crib should be extended down-stream about 400 feet, making the total length of crib 650 feet. Its height should be 11 feet 6 inches.

Nosing on lock-walls.—The original design of lock contemplated a timber nosing placed in a rabbet cut in the coping. Before completion this feature was abandoned and the walls were left with squared corners, without protection to the mooring-lines of boats. During the year timber nosings for this purpose were secured on the lock-walls, one being placed at each of the ten check-posts.

DAM.

Destruction of service bridges of Weir 2.—The extraordinary flood out of the Monongahela River July 9, which attained at this point the height of 20.77 feet, destroyed a great deal of property, principally of the coal operators, who lost heavily in barges and coal-boats loaded with coal for shipment.

The water at Lock No. 4, 44 miles from Pittsburgh, reached the greatest known height on the evening of July 10, it being 39 feet above the lower miter-sill of the lock.

Previous to this flood the Davis Island Dam had been up twenty-two days, and this enabled the coal operators to bring into the Pittsburgh harbor and thus make secure the bulk of their coal

The following are the words used in this connection by a well-known operator: "It

was a godsend that the Davis Island Dam had been up the twenty-two days previous to the flood, for otherwise not a boat or barge would have been saved from destruction, as the first boat adrift would have started others, and they in their turn the entire fleet." This flood was no exception to many previous ones, inasmuch as large quantities of drift-wood accompanied it. So destructive was the flood in the Monongahela Valley that coal-tipples and other coal-mining appliances were destroyed, which helped to swell the mass of débris.

As the rise in the river was expected, we proceeded to lower the dam in the usual manner, *i. e.*, by beginning at the Davis Island or Weir end of dam. By so doing the pool is lowered, and the work on the navigable pass, which is done from the maneuvering boat, is made safe.

The draught of water, created by lowering the weir wickets, lodged in the gap and against the service bridge large masses of drift, composed of coal-flats, coal-tipples, and other débris. The pressure from this accumulation became so great on the service bridge of Weir 2 as to destroy it.

Cross-heads of wickets.—During the fiscal year just closed, as during the years past since the construction of the dam, the steel cross-heads of the navigable pass have given much annoyance by breaking.

In the fall of 1887 it was decided to procure wrought-iron cross-heads to replace all the steel ones. The iron ones were procured and we have been gradually substituting them. During the year we replaced four, making the total of wrought-iron cross-heads sixty-eight, leaving seventy-one yet to be replaced. This work could only be carried on while the dam was being raised, it being considered by the workmen too hazardous to change cross-heads while the dam was up. It was also deemed imprudent to attempt to raise the wickets for the purpose of changing cross-heads after the dam had been down a little while, because the gravel and sand that accumulate between and beneath the wickets drops into the place vacated by them after they are raised, thus preventing the wickets from reseating themselves after the repairs are made. Several attempts were made to do this work with the dam down, but it was found impracticable, as the gravel washed into and around the fastenings of the lower journals of the horses as fast as it could be cleared out, making the work tedious and allowing but little progress.

Scour below dam.—The frequent maneuvers of the dam in the short time it was up caused a scour in the river-bed at Weir 3 to the depth of 13 feet, at a distance of 15 feet below the dam. The scour occurred notwithstanding the large quantities of riprap stone that had been deposited below the dam for its protection. To guard against future injury, it was decided to drive piles in the river-bed below the dam in quincunx order, in rows 5 feet apart, placing the first row 10 feet distant from the foundation, and to fill in between the piles with riprap stone. This work has been started and will be pursued at intervals until perfect protection is secured. On the 8th of October, when the dam was lowered, Weir 3 had been down several hours previous to lowering the pass. The swift current around Pier No. 3 undermined the upper end of it, which overhung the foundation of Weir 3 a distance of 2¾ feet. The upper end of the pier dropped 20 inches, the lower end resting on the foundation of Weir 3. This condition of the pier will not interfere with the operation of the service bridge.

New method of handling dam.—The practice in maneuvering the dam by boat, both in raising and lowering, has been in accordance with the established custom, which is to operate from above. With a clear river, free from drift, this method is very satisfactory; but the difficulties hitherto encountered on account of drift-wood, and the possibility of being compelled to lower the dam with the pool frozen over, as was the case in January, 1888, have led to the introduction of a device for lowering the dam by working from below.

By the new device the boat will be broadside below the dam and out of reach of the overflow. The boat is fastened to the wicket adjacent to the one to be lowered and out of the way of the fall of the latter. By means of a wrought-iron beam, operated by the proper mechanism from the engine on the maneuvering boat, the wicket is pushed forward until the prop drops from the second step of the hurter, the steam is shut off from the engine, and the pressure of the water on the wicket reverses the machinery; the wicket slowly descends until it is free of the catch on the pushing beam, when it drops by its own gravity.

By this method of lowering the dam the boat is placed in a very secure position compared with the method of lowering the dam from above, by which the boat was liable to be drawn through the gap and sunk if a line should break, as happened on one occasion.

It will require very little power to move the boat along the line of the dam as the wickets are dropped, as two friction-rollers will be mounted on the boat, one at each end, which will roll along the back of the dam, and at the same time form a fender to keep the boat at its proper distance.

Drift-gap.—The problem of handling the large quantities of drift-wood which accumulate above the dam, and which have been a source of much labor and annoyance

in years past, is about being solved by the construction of a bear-trap chute in Weir 1. The purpose of this chute is to pass through or over the dam the quantities of drift which hitherto have had to be towed through the lock or tied to the shores on both sides of the river and set adrift after the dam was lowered.

Work on this improvement was commenced August 25 and continued until December 18, 1888, when, on account of high water, operations were suspended for the winter. As the coffer-dam used for the construction of the bear-trap is located within 146 feet of the middle of the river, it was a difficult task to prevent its destruction by floating ice during the winter. Piles for its protection were driven above the coffer-dam; but during the flood of February 19 the ice or other floating objects broke into it, washing out the puddling and destroying the frame-work. A portion of the coffer-dam, 146 feet in length, was thus swept away. To preserve the remaining 327 feet of the coffer-dam additional piles were driven from each upper corner obliquely up-stream for a distance of 150 feet, terminating in a cluster at a common point. These additional piles warded off the ice and prevented any further damage to the coffer-dam.

Operations were resumed April 22, 1889. A row of piles was driven around each pier of the bear-trap to protect it from scour. These will also serve a good purpose in holding up the banks of the excavation for the upper end of the north pier. The high water that prevailed during the week ending May 4 prevented any but preparatory work being done. The rupture made in the coffer-dam during the winter by ice and drift was repaired, the coffer-dam was pumped out and cleared of 2 feet of débris caused by the rupture, and work on the permanent structure continued. The excavation for the upper end of Pier 1 was made to a depth of 6.67 feet below the main sill, and 3½ courses of masonry, each 20 inches in height, were laid. Three courses of masonry have been laid on Pier 2, making the height of this pier 8 feet 4 inches, or the same height as the lower half of Pier 1.

On the evening of May 31 operations on construction were suspended because of an expected rise in the river. Reports indicated that a 12-foot stage of water would be reached, but instead the rise was transformed into a deluge by the sudden releasing of the waters of a mountain lake owned by the South Fork Fishing and Hunting Club.

This lake was formed by damming the South Fork of the Conemaugh River at a point about 2½ miles southward from South Fork Station, on the Pennsylvania Railroad, where the stream empties into the Conemaugh River, South Fork Station being about 11 miles east of Johnstown, in Cambria County. The dam, which had a height of 72 feet, gave way about 3 o'clock on the afternoon of May 31, and the vast body of water, which had an area of 400 acres, was precipitated with stupendous force into the valleys on the South Fork and the Conemaugh River.

Enormous rains had fallen in this mountain region, and both the Allegheny and Monongahela Rivers rose rapidly. The great volume of water began to reach Davis Island Dam at midnight, at which time the gauge read 13½ feet. So sudden was the coming, that it was then impossible to protect our machinery and appliances from damage. We succeeded in getting all our boats to the island, but the engine, pump, and derricks remained in position. The river began to rise at 6 p. m. May 31, when the gauge showed 6.42 feet, and the rise reached its maximum at 6 p. m. June, 1 when the gauge showed 22.36 feet. The rains at headwaters since the breakage of the South Fork Dam kept the river at a high stage, and it was not until the morning of June 5 that the fall was sufficient for us to ascertain the condition of the work.

The steam-engine was forced off of the pier into the coffer-dam inclosure, and the two derricks were knocked down, but are uninjured. Two hundred and thirty-six feet of the coffer-dam was destroyed, and will require rebuilding before operations on the permanent work can be resumed. The frame of the centrifugal pump was broken; the discharge-pipe, 28 feet long, one section of 2-inch shaft, 10 feet long, with pulley, were lost. The steam-engine was not damaged beyond breaking the governor and a few pipe connections. Considerable of the lumber from the coffer-dam has been recovered and can be utilized.

Operations were again resumed on the 7th instant. The wreck of the coffer-dam has been cleared out; the engine, pump, and derricks put in order for service. Work was again suspended on the 15th on account of another rise in the river which lasted until the 25th, when work was again resumed, and was in progress at the close of the fiscal year.

Back River Dam.—This dam is a permanent structure, 465 feet long, its crest having the same reference as the movable dam, and connects Davis Island with the south shore. Since the construction of this dam, seven years ago, the channel above it has been filled to a depth of 6 feet by natural deposit.

Below the dam no scour has taken place; on the contrary, a hole 10 feet deep, which existed there when the dam was finished, has been filled in to within 1 foot of the tail of the dam, the fill extending an indefinite distance below the dam with a uniform fall of about 3 per cent. The tail of the dam is constructed with a rising in-

clination of 0.75 feet vertical to 5 feet horizontal, which gives such action to the falling water as to prevent injury to the river-bed below the dam.

The structure never sustained injury from ice or other cause, except that some of the sheeting was torn off the down-stream face. In replacing the few plank torn off long drift-bolts were used instead of the ordinary spikes, and the plank thus put on are secure. At present a few plank are off the down-stream face; a result of the late flood. The river is yet too high to ascertain whether or not the tail of the dam sustained any injury.

The guiding-cribs are in good condition, as is also the ramp at the south end of the dam.

The wagon-way over the ramp is advantageously used for the purpose for which it was designed. The Back River Dam in all its belongings I consider in good condition.

MISCELLANEOUS.

Natural gas.—Our supply of natural gas for fuel and light on the lock side of the river is still received from the Fort Pitt Natural Gas Company, under a written contract, at the rate of $350 per annum.

The gas for the torch on Davis Island is supplied by the Bellevue Natural Gas Company, whose lines cross Davis Island. The gas is supplied for the torch in consideration of the right of way for laying their pipes across the island.

Operation of dam.—The dam was up at the beginning of the fiscal year and was maneuvered on the following dates:

Lowered on July 10; up nine days.
Raised on July 28.
Lowered on August 19; up twenty-three days.
Raised on September 8.
Lowered on September 10; up three days.
Raised on September 17.
Lowered on October 8; up twenty-two days.
Dam up during the fiscal year, fifty-seven days.

During the maneuver of July 10 the accumulation of drift behind the maneuvering boat made it impossible to pull the boat back.

The steamer *D. B. Wood* was called to our assistance and towed our maneuvering boat to the rear of the drift-pile, which we pushed ahead of us into the gap. We were thus enabled to resume the operation of lowering the dam. In lowering the dam on August 19 the same difficulty with drift was experienced. We were assisted on this occasion by the steamer *Maggie*.

We hope in the future to avoid all difficulty from drift by the adoption of the new method of lowering the dam by working from below, described in another part of this report.

Working force.—Our working force consists of eight men, and is divided into equal parties, one for operating the lock and the other the dam. When the dam is up each party attends solely to its respective duties, but when the dam is being raised or lowered both parties engage in this work, except one man, who attends to the lock.

I take this occasion to attest to the faithful services of Mr. J. W. Riggs, the chief lock-keeper, who has directed the working parties, and to the several assistants composing the force both on the lock and dam.

D D 3.

IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

During 1888 the masonry of the lock was completed and the terreplein and slopes were graded. To put the lock in condition for service it is necessary to lay the miter-sills, to build and place the gates, to set the operating machinery, and to dredge the outlet and the inlet. In addition to the above it will be necessary to place a guiding-crib above the river wall and a dry wall below the land wall, to pave the slopes and terreplein of the lock, and to build a lock-keeper's house; but all of this can be done after the lock is in operation.

The abutment was entirely completed and the bank graded in 1888.

A contract for building the dam was let on the 17th of January, 1889, to C. I. McDonald, of Pittsburgh, and the work is to be completed on or before the close of the calendar year.

The contractors for furnishing lock timber, Messrs. Mapel Brothers and Titus, having failed to furnish any timber that would pass inspection, their contract was annulled and arrangements made to purchase timber in open market.

A contract for furnishing machinery for the lock was made with Messrs. Lambert Bros. & Co., of Ironton, Ohio, under date of June 17, 1889.

Work during the fiscal year was greatly embarrassed by floods, that of July, 1888, having been the highest on record in the Monongahela River, being 37 feet above low water at the site of the lock.

At the close of the fiscal year, there is every prospect that the lock and dam will be completed and opened to navigation before the close of 1889.

For further details reference is made to the report of Mr. P. J. Schopp, the resident engineer, hereto annexed.

If it is the design of Congress to continue the improvement of the Monongahela River above Morgantown, in accordance with my report of December 11, 1875 (Report of Chief of Engineers, 1876, Part II, page 129), the time has now come for making a beginning, for which an appropriation of $50,000 will be required.

Money statement.

July 1, 1888, amount available		$49,861.97
Amount appropriated by act of August 11, 1888		35,000.00
		84,861.97
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$13,534.65	
July 1, 1889, outstanding liabilities	703.97	
July 1, 1889, amount covered by existing contracts	38,727.08	
		52,965.70
July 1, 1889, balance available		31,896.27
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		50,000.00

Abstract of proposals for furnishing white oak timber for gates and miter-sills of Lock No. 8, Monongahela River, opened June 15, 1888.

No.	Name and address of bidder.	Per 1,000 feet, B. M.
1	Mapel Bros. & Titus, Greensborough, Pa	$39.97½
2	Alpheus Dilliner, Stewartstown, W. Va	40.00
3	C. L. Stoner, Pittsburgh, Pa	47.50

Contract awarded to Mapel Bros. & Titus, and executed under date of July 19, 1888.

Abstract of proposals for constructing Dam No. 8, Monongahela River, opened January 8, 1889.

No.	Name and address of bidder.	Timber per M.	Bolts per pound.	Spikes per pound.	Stone per cubic yard.	Backing per cubic yard.	Aggregate.
			Cents.	*Cents.*			
1	C. I. McDonald, Pittsburgh, Pa	$24.00	4	4	$1.17	$1.09	$38,727.09
2	Andrew W. McDonald, Corsopolis, Pa	31.75	5½	4½	.96	.60	42,668.73
3	Hoag & Petitdidier, Pittsburgh, Pa	28.00	4	4	1.58	.25	44,039.78
4	J. R. King & Co., Belpre, Ohio	45.00	5	5	1.00	.75	53,453.35
5	Free & Meredith Consolidated Company, Pittsburgh, Pa	50.00	4	3	2.00	2.00	71,879.06

Contract awarded to C. I. McDonald, and executed under date of January 17, 1889.

Abstract of proposals for furnishing and delivering the operating machinery for Lock No. 8, Monongahela River, opened June 6, 1889.

No.	Name and address of bidder.	Wrought iron per pound.	Cast iron per pound.	Steel per pound.	Total.
		Cents.	*Cents.*	*Cents.*	
1	Lambert Bros. & Co., Ironton, Ohio	7	7.3	12.5	$3,889.63
2	Hœfinghoff & Lane F'd'y Company, Cincinnati, Ohio	9.5	6	27	3,966.29
3	Vulcan Iron Works, Chicago, Ill	10.5	5.9	17.9	4,088.35
4	The I & E. Greenwald Company, Cincinnati, Ohio	7.75	7.75	7.75	4,140.44
5	West Point Manufacturing Company, "Limited," West Point, Pa	9.5	7.75	9	4,448.12
6	Detrick & Harvey, Baltimore, Md	7.75	8.5	15	4,464.58
7	John G. Fritsch, Cincinnati, Ohio	10.7	7.2	11.2	4,473.77
8	Universal Radial Drill Company, Cincinnati, Ohio	9.45	9	29	5,042.04

Contract awarded to Lambert Bros. & Co., and executed under date of June 17, 1889.

REPORT OF MR. PHIL. J. SCHOPP, ASSISTANT ENGINEER.

At the beginning of the fiscal year the Monongahela Valley was visited by the highest flood on record. The water reached its highest point on July 10, on which date it stood 36.90 feet above low water of Pool No. 7. Lock No. 8 and the land adjoining were flooded; tramways, derricks, hoisting and pumping machinery were displaced by the irresistible current; owing, however, to the precaution of securing the tools and plant by tying to trees, etc., very little damage was done, and the loss consisted principally in the labor of replacing articles dislodged by the flood.

The land-wall and wing-walls of the lock have been finished. The coping of the wings was extended 25 feet further in order to reach the foot of the bank. This additional coping rests on beds of concrete on well-settled ground.

The lock-chamber, which had not been previously excavated, was cleaned out, the excavated material being deposited behind the land-wall. The filling behind the land-wall was completed by taking material from the high bank opposite the lock. The terre-plein is now 80 feet wide, from face of wall to foot of bank, which latter is graded with a slope of 1 on 2. The contractors for gate-timber having failed to comply with the terms of their contract, the necessary timber has been purchased in open market.

All the iron work necessary for constructing and anchoring the gates has been received.

The timber for the movable dam in the head bay of the lock has been purchased, and construction commenced.

The abutment on the left bank of the river has been finished, rising 42 feet from the bed-rock of the river. The filling behind the abutment and the grading of the bank has also been completed. A contract has been made with C. I. McDonald for the construction of a crib-dam across the river between the lock and abutment. The contractor is now engaged in securing the necessary material for the dam, which is to be completed during the present season.

The land of the United States at Lock No. 8 being entirely surrounded by private property, it is found necessary to purchase a strip of ground for a roadway connecting with the public road. Negotiations for the purchase are under way.

To finish the improvement at Lock No. 8 the following is yet required: Construction and hanging of gates, construction and placing of operating machinery, construction of movable dam at head-bay of lock, construction of dam across the river, construction of a guiding crib at entrance of the lock and of a guide-wall at the lower end of lock, paving the slope, building lock-keeper's house, fencing the ground, and erecting a tool-house and small workshop.

COMMERCIAL STATISTICS.

The following statistics, taken from the annual reports of the Monongahela Navigation Company, show the commercial movements on the lower or northern end of the river for six years ending December 31, 1888:

Articles.	1883.	1884.	1885.	1886.	1887.	1888.
Brick ..... number..	1,806,161	652,126	588,892	3,998,802	2,346,223	2,001,996
Cattle and horses ..... do	766	289	998	1,029	1,357	1,568
Classified freight .. pounds..	35,179,470	27,779,991	27,365,266	26,171,201	32,972,756	34,300,650
Coal, coke, and slack, bushels	112,395,389	81,706,852	85,923,107	113,099,147	78,912,900	115,814,900
Fire-clay ..... tons..	5,794	2,140	3,463	3,295	2,383	3,476
Hogs ..... number..	.....	3,381	1,845	1,105	3,451	5,057
Iron ore ..... tons..	31,681	20,840	16,486	17,823	17,663	8,079
Iron in pigs ..... do	785	17	11½	5	7	10
Lumber ..... feet..	11,759,890	7,142,447	6,414,212	6,820,804	7,429,350	9,185,400
Oil ..... barrels..	1,479	52	4,073	.....	307	.....
Pipe ..... tons..	.....	.....	595	.....	2,285	.....
Posts ..... number..	2,800	255	12,826	21,853	12,886	24,430
Posts, pit ..... do	252,905	219,200	201,040	114,950	190,450	140,200
Railroad ties ..... do	57,000	16,750	1,800	2,150	400	7,400
Sand ..... bushels..	733,700	679,000	941,300	1,076,900	1,622,000	1,147,000
Sheep ..... number..	.....	5,677	4,464	3,600	7,771	6,440
Sheep and hogs ..... do	11,017	.....	.....	.....	.....	.....
Staves ..... do	135,000	.....	4,000	4,000	.....	3,000
Steel rails ..... tons..	43,946	23,844	22,428	45,795	57,490	10,688
Stone ..... perches..	15,635	32,067	4,350	2,641	529	2,078
Timber ..... feet..	3,635,624	2,091,740	2,052,100	2,342,146	2,380,490	3,741,830
Whisky ..... barrels..	5,719	6,770	5,293	4,374	1,317	2,360
Wood ..... cords..	32	.....	120	102	.....	96
Passengers ..... number..	26,058	26,871	24,698	26,885	50,584	44,714

For statistics of the commercial movement on the upper end of the river, see report on operating and care of Lock and Dam No. 9.

DD 4.

OPERATING AND CARE OF LOCK AND DAM NO. 9, MONONGAHELA RIVER.

During the year authority was received to raise the lower part of the lock-walls to the same height as the upper part, in order to increase the guard of the lock, the old guard having proved too low.

It was hoped that this work could be completed in one season, but this was found to be impracticable. Both of the lower buttresses were raised 3¼ feet, the height of the lower lock-gates was increased by the same amount, one course was laid on the land wall between the buttresses, and the apparatus of the Stoney valve was adapted to the new conditions. To complete this work it is necessary to raise the chamber walls by one course on the land side and two on the river side, and to fill in and pave behind the land wall.

The upper arm of the upper lock-gate has become decayed and must be replaced, and a few stones should be added to the abutment to guard against scour behind it.

The unprecedented flood of July, 1888, rose several feet above the top of the banks and carried away the lock-keeper's house, the store-house, and the blacksmith's shop, being all of the buildings which belonged to the work. A new lock-keeper's house must therefore be built, but this is not immediately necessary, as the present lock-keeper occupies his own quarters.

The dam is in good order, and since the addition of the crib apron on the lower side there has been no injury from drift or undermining.

The defective river wall was repaired by injecting 140 barrels of cement through drill-holes, and 75 barrels were also injected into the land wall. The cavities in these walls were not wholly filled, but their condition has been decidedly improved.

The tract of land attached to the lock is so small that it is proposed to purchase a small additional tract below the lock, so as to control the approaches to the lock from both directions.

For further details reference is made to the annexed report of Mr. P. J. Schoop, resident engineer.

Detailed statement of expenses incurred at Lock and Dam No. 9, Monongahela River, during the fiscal year ending June 30, 1889.

Month.	General administration.			Equipment.	Repairs.			Grand total.
	Salary of lock-keeper.	Miscellaneous expenses.	Total.		Labor.	Materials	Total.	
1888.								
July		$4.50	$4.50	$12.60				$17.10
August	$50.00	.20	50.20	224.76	$263.52	$3.50	$267.02	541.98
September		37.01	37.01	75.32	1,185.76	234.98	1,420.74	1,533.07
October		53.26	53.26	44.10	2,117.91	27.21	2,145.12	2,242.48
November					2,242.12	42.20	2,284.32	2,284.32
December	50.00	51.02	101.02	3.65	1,023.05	628.67	1,651.72	1,756.39
1889.								
January	50.00	1.63	51.63			26.88	26.88	78.51
February	50.00		50.00			2.65	2.65	52.65
March	50.00	2.02	52.02					52.02
April	50.00		50.00	.42				50.42
May	50.00		50.00					50.00
June	50.00		50.00					50.00
Total	400.00	149.64	549.64	360.85	6,832.36	966.09	7,798.45	8,708.94

Estimate for fiscal year ending June 30, 1890.

Raising lock-walls	$3,150	Purchase of land	$500
Repair of upper lock-walls	550	Salary of lock-keeper	600
Filling and paving behind land wall	850		
Raising abutment	800	Total	6,450

Commerce passing Lock No. 9, Monongahela River, during the fiscal year ending June 30, 1889.

Date.	Lockages.	Up.			Down.					
		Barges and flats.	Miscellaneous.	Merchandise.	Barges and flats.	Rafts.	Miscellaneous.	Merchandise.	Lumber.	Timber.
1888.				Tons.				Tons.	Ft., B.M.	Cub. ft.
July										
August	46	2	8		2	30	7		31,000	70,000
September	17	1	2		1	15	3		178,000	12,500
October	6	2			2	5			80,000	
November										
December	2		1				1			
1889.										
January	13	3	4	41	2	1	5		2,000	
February										
March	8	2	1		3	1	1	1	25,000	
April	54		5			56	4		576,000	115,500
May	20	2	10	1½	2		8	4		
June	22		5			18	6		100,000	42,000

REPORT OF PHIL. J. SCHOPP, ASSISTANT ENGINEER.

The following programme of improvements was decided upon at the beginning of the fiscal year.

To raise the lock-walls 40 inches, bringing them up to the level of the upper buttresses, to raise the lower gates, and to repair the upper gates, the upper arms of which were very rotten; to fill the space between the raised land-wall and the bank, necessitating the taking up and relaying of the existing paving; to grout the lock-walls, to repair the machinery of the discharge valve; to improve the abutment on the left bank of the river, by building up the central wing perpendicularly and raising the abutment below it.

This programme could be carried out only in part.

Before work was commenced the July flood had done considerable damage around the lock, carrying away all the buildings belonging to the United States. These buildings were of frame, and consisted of an office, carpenter shop, blacksmith shop, tool shed, and stable, and the fence around the lot. It was necessary to erect temporary buildings and repair damages before beginning work on the lock. A tool shed, smith shop, and carpenter shop, with small office attached, were put up. This unexpected outlay somewhat reduced the amount available for the repairs of the lock and abutment.

To get the stones for the lock-walls a quarry had to be opened, and a good one was found opposite the village of Granville, on the Monongahela River, about 6 miles above the lock. Five hundred cubic yards of stone are needed for the contemplated improvements, of which 300 cubic yards have been quarried, leaving 205 cubic yards yet to be procured.

On the lock-walls 251 cubic yards of masonry were laid, leaving 186 cubic yards yet to be placed. The lower buttresses were raised 40 inches and were finished. The remainder of the land-wall was raised 20 inches. With the exception of the buttress, no stones were laid on the river wall.

The lower gates have been raised 40 inches, corresponding with the elevation of the buttress.

Both lock-walls have been grouted. The operating machinery of the discharge valve, known as the Stoney valve, has been put in good working order; the bed plate has been firmly set and a new upright shaft with new pinion and spur-wheels put in place.

On account of the lateness of the season nothing else could be done. What remains to be done is to finish the lock-walls, for which stones will have to be cut; to raise the abutment, to repair upper gates, to fill between land-wall and bank, and to repave the space behind this wall.

D D 5.

IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

Owing to the late date at which the river and harbor act of 1888 was passed and to the wetness of the season, it was impossible to carry into effect any plans for improvement. A break had been discovered in the dam at the head of Six-Mile Island, but the dam remained continuously under water and nothing could be done beyond accumulating materials.

A contract has been made for the construction of a dike at the mouth of Red Bank Creek; and the construction of two riprap dams at the Cornplanter Islands will be begun as soon as the stage of the river will permit.

Water-gauges have been established at Parker's Landing and at Freeport, primarily in order to give flood warnings to the Davis Island dam, but they will also be useful to Allegheny River commerce.

It is proposed to expend further appropriations in the construction of dikes and low dams wherever abnormal width of river or the existence of duplicate channels make them advantageous.

The commerce of the river is still small, but it has experienced much benefit from the work already done.

For further details and for commercial statistics reference is made to the annexed report of Mr. J. W. Arras, the resident engineer.

ESTIMATE.

For continuing the work of building low dams and dikes and removing rocks an estimate of $50,000 is submitted.

Money statement.

July 1, 1888, amount available		$659.33
Amount appropriated by act of August 11, 1888		25,000.00
		25,659.33
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$2,555.25	
July 1, 1889, outstanding liabilities	270.00	
July 1, 1889, amount covered by existing contracts	13,783.95	
		16,609.20
July 1, 1889, balance available		9,050.13
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.		50,000.00

Abstract of proposals for constructing dike at Red Bank Creek, Allegheny River, opened January 8, 1889.

No.	Name and address of bidder.	Oak timber, per M.	Hemlock timber, per M.	Riprap stone, per cubic yard.	Paving, per square.	Drift bolts, per pound.	Spikes, per pound.	Aggregate.
						Cts.	*Cts.*	
1	John J. Shipman, Washington, D. C.	$24.00	$19.50	$0.93	$1.10	4	6	$13,783.95
2	Joshua R. King, Belpre, Ohio	28.00	20.00	.90	1.50	4½	4	14,388.21
3	Andrew W. McDonald, Coraopolis, Pa.	27.75	18.00	.90	5.33	4½	4½	15,035.83
4	I. V. Hoag, jr., Pittsburgh, Pa	23.00	19.00	1.25	1.95	3	3	15,467.40
5	John F. King, Belpre, Ohio	27.00	20.00	1.33	.....	3½	7	16,441.80
6	C J. McDonald, Pittsburgh, Pa	27.00	19.50	.99	7.50	7½	7½	16,954.05
7	Free & Meredith Construction Company, Pittsburgh, Pa	38.00	30.00	1.50	2.00	4	4	21,320.20
8	Wellman & Henry, Kittanning, Pa	23.50	18.50	1.85	14.50	¼	3½	23,151.90
9	J. L. Long & Co., Freeport, Pa	30.00	20.00	2.00	10.00	10	10	24,982.00
10	F. Gwinner, Allegheny, Pa	35.00	24.00	2.20	14.00	3½	4	26,560.00
11	P. J. Linnon and G. A. Mack, Kittanning, Pa	38.00	28.00	4.50	15.50	2½	3½	42,228.95

Contract awarded to John J. Shipman, and executed under date of January 17, 1889.

REPORT OF J. W. ARRAS, ASSISTANT ENGINEER.

The following improvements were proposed under the appropriation of $25,000 made by the act of August 11, 1888.

Cornplanter Island, 204 miles above Pittsburgh.—An embankment to be built across the chute between the two lower of the group of three islands. The channel passing to the right of these islands is so much drained at points as to render navigation very difficult and uncertain; this channel is to be improved by shutting off the left chute at the head, and that between the two upper islands with low dams of heavy riprap stone built to a 6-foot stage, at an estimated cost of $1,840. Operations have not as yet been commenced on account of high water.

Red Bank Ripple, 64 miles above Pittsburgh.—A dike to be constructed from the right bank nearly opposite the mouth of Red Bank Creek. This point is the shoalest between Oil City and Pittsburgh, and is known to all rivermen as the "sticking point." The object of the dike is to confine the water to a definite channel on the left. The structure will be about 1,600 feet long, and will be built to the height of the 6-foot stage in the river. It will consist of a substantial crib-work filled with stone and carefully paved. The work is being done under contract with Mr. J. J Shipman, dated January 17, 1889. Mr. R. B. Wick, civil engineer, is the inspector in charge of its construction. Much of the material for the work is on the ground ready to put in place when the water reaches a working stage.

Dam at Six-Mile Island, 6 miles above Pittsburgh.—Lower half of dam to be reconstructed for a length of 440 feet. This part of the dam was built in 1879, and its strength has become greatly impaired, 100 feet of the back slope having been entirely carried away by the combined action of floods, ice, and drift. Timber, stone, and bolts for this work were at once procured and a force was set to work recovering the stone that had been scoured out by the water. Before the work of repair could be commenced, however, the water rose above the crest of the dam, and, continuing high, compelled a suspension of operations for the season. Subsequently the timber was placed on the bank for safety during the winter.

Water-gauges.—Two water-gauges were erected on the Allegheny River last season, one at Parker's Landing, 82 miles above, and one at Freeport, 28 miles above Pittsburgh, at a cost of $145.55. These gauges consist of graduated iron plates carefully fastened to a cap timber well secured to posts, which are firmly planted in the bank; the upper surfaces lie flush with the surface of the bank, so as to form no obstruction. In addition to the information they give to navigators, these gauges are utilized in furnishing reliable information as to the stages of water in the Allegheny River for use in connection with operating the movable dam in the Ohio River at Davis Island. They will also be indispensable in connection with the building of the Herr's Island Dam, near Pittsburgh.

It is interesting to note the effect of each improvement of the Allegheny upon the trade of this river, not only of improvements already made, but of those under way as well. Red Bank Ripple has always been an uncertain point to navigation, showing only from 6 to 12 inches of water, while at other points there was a navigable depth of nearly 2 feet. Notwithstanding the fact, however, that the proposed remedy is but little more than begun, the report is received that a packet is already being built to ply between East Brady and Pittsburgh, a distance of 68 miles, passing over this ripple.

Much relief can be given the struggling commerce of the river by continuing the class of work now under way, as many localities remain that require improvement. I would call special attention to three of these places, viz, Hickory Ripple, Pithole Ripple, and Cowanshamrock Ripple. At each of these a dike is needed to better its condition.

COMMERCIAL STATISTICS.

As heretofore a statement containing only an approximate estimate of some of the more important items of the commerce of the Allegheny can be given, as no official record of the trade is kept. It is regretted that the minor trade, which forms so important feature of the whole, must be entirely omitted, but it is impracticable to gather statistics of this trade on account of its scattered nature.

Commerce of the Allegheny River for year ending June 30, 1889.

Articles.	Quantity.	Articles.	Quantity.
Apples.....bushels..	1,700	Limestone.....tons..	700
Barges.....number..	30	Oil, crude (in bulk).....barrels..	14,000
Bark.....cords..	1,800	Piles.....number..	8,000
Barrels.....number..	134,396	Paving stones.....cubic yards.	5,400
Boat bottoms.....do....	1,000	Railroad ties.....number..	80,000
Brick.....do....	80,000	Rough lumber.....feet, B. M..	130,000,000
Fire-clay.....tons..	1,500	Sand.....bushels..	1,000,000
Gas-pipe.....do...	300	Staves.....number..	353,236
General freight.....pounds..	1,000,000	Stone.....cubic yards..	9,000
Hay.....bales..	5,600	Timber.....cubic feet..	5,300,000

In addition to these I am able to give a few of the principal commercial movements in the Allegheny Harbor at Pittsburgh:

Articles.	Quantity.	Articles.	Quantity.
Coal.....bushels..	6,000,000	Sand.....bushels..	1,500,000
Gravel.....do....	500,000	Vegetables.....do....	100,000
Railroad ties.....number..	150,000		

D D 6.

DAM AT HERR'S ISLAND, ALLEGHENY RIVER.

The whole of the fiscal year has been employed in making plats of the land required for the lock and abutment of this dam and in endeavoring to procure the necessary land; and while some progress has been made no definite understanding with the land owners has yet been reached. A detailed statement of the present condition of negotiations will be found in the annexed report of Mr. Arras.

ESTIMATE.

As the construction of a lock in a river subject to heavy ice-floods is a somewhat hazardous undertaking it is evidently inexpedient and wasteful to prolong the period of construction. I therefore submit an estimate of $100,000 for the next fiscal year. It is probable that the whole of the sum now in hand will be absorbed in acquiring the necessary land.

Money statement.

July 1, 1888, amount available		$36,592.00
Amount appropriated by act of August 11, 1888		35,000.00
		71,592.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$860.22	
July 1, 1889, outstanding liabilities	30.00	
		890.22
July 1, 1889, balance available		70,701.78
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		100,000.00

REPORT OF J. W. ARRAS, ASSISTANT ENGINEER.

The survey commenced in June, 1888, to establish definitely the lines of the proposed Herr's Island Lock and Dam was completed, and a map of the location and adjoining properties and interests made and submitted. The approved location fixes the dam directly opposite Twenty-second street, Pittsburgh, and a little above Pine street in Allegheny City. The lock is located on the Pittsburgh side of the river, and the lock and guide-walls together occupy the river front on that side from Twentieth street to Twenty-fourth street, a distance of 1,237 feet. In Allegheny City the wharf for a length of 400 feet is required for the abutment of the dam.

It being first necessary to acquire title to the land to be occupied by the dam, the legal assistance of the United States attorney for the western district of Pennsylvania was secured to this end. After careful data had been procured with a view to securing all of the land within the prescribed limits of the lock and abutments, it was suggested by the United States attorney that all lands situated between the high-water lines of the river belong to the United States for the purpose of making and maintaining improvements for navigation. Acting on this suggestion, efforts were at once limited to the acquirement of the remaining two lots, viz, a lot 110 by about 106 feet, on Twenty-second street in Pittsburgh, on which to build a lock-keeper's house, and a strip of the Allegheny City Wharf, 400 feet long and extending from the high-water line to the top of the bank, whereon to abut and protect the dam.

As was anticipated, some difficulty is being experienced in acquiring possession of these lots, which are in sections crowded with manufactories, for although low river lands are nearly worthless for any other purpose, they are very desirable as sites for factories.

For the lock-house lot negotiations were opened with the owner, Mr. J. J. Vandergrift, but the price asked being considered unreasonably high, condemnation proceedings were at once instituted. Viewers have been appointed by the court to appraise the lot, and their action in the matter is now awaited. It was decided to ask the city of Allegheny through its council for a grant of the desired strip of wharf on which to build the abutment of the dam, and accordingly a petition was presented to that body requesting that title to the lot be conveyed to the United States. After considerable delay an interest has finally been aroused, and it is encouraging to know that the matter is looked on with favor, and that an ordinance to effect this conveyance has been ordered prepared by the council.

DD 7.

ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO.

The ice-harbor is the lower pool of the Muskingum River, which has been created by the slackwater dam at Marietta, and the object of the work under consideration is to build a pass-way through this dam of such size as will permit Ohio River packets and coal fleets to take refuge from ice in this pool. The pass-way in question consists of a large lock, which, owing to the local conditions controlling the only available

site, had to be built with independent axes of entrance and exit, the angle between these axes being 11° 15′. This involved the necessity of widening the lock-chamber at both ends, so as to permit boats to change direction while in the lock. The plan of the lock-chamber is therefore somewhat like an hour-glass, the lock being narrowest at the middle. The maximum rectangle which can be passed through the lock has a length of 365 feet and a width of 56 feet. The work has been in progress since 1880, but has been kept back by inadequate appropriations and the occasional absence of any appropriation.

I regret to have to state that the work of last season was a practical failure, owing to the constant succession of rises in the Ohio River, the details of which may be found in the report on that river.

Work was resumed on the 18th of August, 1888, as soon as possible after the passage of the river and harbor act. On the 3d of September the water in the coffer-dam was pumped out; on the 8th the coffer was flooded by a rise in the Ohio; on the 15th the rise had subsided and it was again pumped out; on the 16th it was again flooded; on the 23d it was again pumped out and the work of concreting the floor was resumed; on the 12th of October the coffer was again flooded and on the 22d of November, as the coffer was still under water, it was considered useless to make any further effort, and work was closed for the season.

From the above it will be seen that the water was out of the coffer during three periods of five days, one day and nineteen days respectively. No work of construction could be done during the first two periods, and part of the third was used up in removing the deposits which had accumulated since work closed in 1887.

The net result of the season's work was the laying of 250 cubic yards of concrete and 300 cubic yards of masonry and the cutting of a large quantity of stone.

This was the worst season for lock building that we have ever had; but more interference by high water than formerly is to be expected, as we are now working on the lower part of the lock, which is under the influence of the Ohio River.

I regret to have to report that the engineer in charge of this work, Mr. William Weston, who had been in charge of the Ice-Harbor Lock from the beginning, and had been my principal civil assistant since 1870, died at Manàos, Brazil, of yellow fever, on the 27th of March, 1889. He was traveling for pleasure during the period of suspension of work, as had been his custom for several years. His death has been a serious loss both socially and professionally, as he was a man of the highest character and an engineer of rare attainments in his profession.

Work was resumed in June, 1889, with Mr. Cabell Breckinridge, C. E., as resident engineer. At the close of the fiscal year the water was over the lower coffer, and work had been limited to general preparation and to the removal of the two isolated piers above the lock, which had been built with Buffalo cement, and were so badly damaged by the swelling of this cement as to require reconstruction.

ESTIMATE.

Owing to the impracticability of doing any work last season the money expended in starting the works, pumping out, repairing coffer-dam, removing mud, etc., was unavoidably wasted. Had the funds in hand been available in 1887, when we had a year of extraordinary low water, the lock could have been finished with ease and this loss could have been saved. Under the circumstances I am under the necessity of requesting $15,000 to finish the work.

Money statement.

July 1, 1888, amount available		$1,162.46
Amount appropriated by act of August 11, 1888		60,000.00
		61,162.46
July 1, 1889, amount expended during fiscal year, exclusive of outstanding liabilities	$23,811.79	
July 1, 1889, outstanding liabilities	1,730.22	
July 1, 1889, amount covered by existing contracts	947.30	
		26,489.31
July 1, 1889, balance available		34,673.15
Amount (estimated) required for completion of existing project		15,000.00
Amount that can be profitably expended fiscal year ending June 30, 1891		15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for furnishing white-oak timber for the gates of the ice-harbor lock at the mouth of Muskingum River, opened February 21, 1889.

No.	Name and address of bidder.	Per 1,000 feet, B. M	Aggregate.
1	D. M. Wolf, McLuney, Ohio	$32.00	$960.00
2	F. S. Shurick, Marietta, Ohio	33.00	990.00
3	Joshua R. King, Belpre, Ohio	36.00	1,080.00
4	Alexander McClure, Pittsburgh, Pa	49.00	1,470.00

Contract awarded to D. M. Wolf, and executed under date of March 14, 1889.

D D 8.

IMPROVEMENT OF MUSKINGUM RIVER, OHIO.

The maintenance of navigation on this river is borne by the indefinite appropriation for "Operating and care of canals," etc., but the river and harbor act of August 11, 1888, contained the following item: "Improving Muskingum River, Ohio: For the construction of a lock at Taylorsville and the reconstruction of the lock at Zanesville, pursuant to the report of the engineers, $102,000."

This appropriation was evidently based on my report of December 24, 1887. (Report of Chief of Engineers, 1888, page 1701.) In that report the estimated cost of changing the flight of two locks at Zanesville to a single lock was placed at $12,000. The Secretary of War having decided that the estimated cost of new gates at this locality ($3,300) should be borne by this appropriation, it was evidently impracticable to undertake to change the two locks into a single one, and no steps were taken to that end.

Since that report was sent to Congress other considerations have made their appearance, and while I think the change to a single lock very desirable, if the locks are to remain at their present location there are strong reasons for desiring a change in the terminus of the Zanesville Canal, and hence it seems inadvisable to incur the expense of mod-

ifying structures that may be taken down within a few years. I would therefore recommend that nothing be done in this matter for the present.

The new lock at Taylorsville is under contract, dated April 25, 1889, with A. J. Jolly & Sons. It is to be completed by August 31, 1890. At the close of the fiscal year the coffer-dam had been completed and pumped out twice, work having been once interrupted by high water. Some excavation for the foundation had been made, and a considerable quantity of stone for the wall had been quarried and dressed.

As far as is now known no further appropriation is required, and hence no estimate is submitted.

Money statement.

Amount appropriated by act of August 11, 1888		$102,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$183.25	
July 1, 1889, outstanding liabilities	136.00	
July 1, 1889, amount covered by existing contracts	61,340.62	
		61,659.87
July 1, 1889, balance available		40,340.13

Abstract of proposals for constructing a lock on the Muskingum River at Taylorsville, Ohio, opened April 4, 1889.

Number.	Name and address of bidder.	Fine pointed, per cubic yard.	Rough pointed, per cubic yard.	Masonry.			
				Rock face, per cubic yard.	Dry, per cubic yard.	Brick per cubic yard.	Concrete, per cubic yard.
1	A. J. Jolly & Son, Pittsburgh, Pa	950	950	750	600	600	400
2	Hughes Bro's, Syracuse, N. Y	1,500	1,400	675	400	850	500
3	Harrold & McDonald, Pittsburgh, Pa	1,250	990	750	525	775	585
4	C. I. McDonald, Pittsburgh, Pa	1,075	975	750	600	900	750
5	J. Hugill & Co., Akron, Ohio	1,200	1,100	900	800	800	500
6	Hoag & Petitdidier, Pittsburgh, Pa	1,470	1,300	1,060	350	1,600	800
7	T. B. Townsend, Zanesville, Ohio	1,450	1,400	1,075	825	1,225	750
8	W. A. Snodgrass, Marietta, Ohio	1,350	1,200	1,000	825	1,250	1,000

Number.	Name and address of bidder.	Timber and plank, per M.	Excavation.			Filling behind land wall of lock, per cubic yard.	Aggregate.
			Earth, per cubic yard.	Loose rock, per cubic yard.	Rock, per cubic yard.		
1	A. J. Jolly & Son, Pittsburgh, Pa	2,200	80	80	100	30	61,340.62
2	Hughes Bro's, Syracuse, N. Y	4,500	40	70	125	30	65,827.60
3	Harrold & McDonald, Pittsburgh, Pa	3,000	155	165	225	50	72,471.67
4	C. I. McDonald, Pittsburgh, Pa	3,000	200	250	300	30	75,515.82
5	J. Hugill & Co., Akron, Ohio	2,800	100	200	98	40	78,236.53
6	Hoag & Petitdidier, Pittsburgh, Pa	5,000	100	130	250	50	88,110.75
7	T. B. Townsend, Zanesville, Ohio	3,000	40	100	300	50	90,146.32
8	W. A. Snodgrass, Marietta, Ohio	4,000	100	250	350	85	93,662.26

Contract awarded to A. J. Jolly & Sons, and executed under date of April 25, 1889.

D D 9.

OPERATING AND CARE OF THE LOCKS AND DAMS ON THE MUSKINGUM RIVER, OHIO.

The work of operating and maintaining the locks and dams on the Muskingum River has been under the local charge of First Lieut. L. H. Beach, Corps of Engineers, assisted by First Lieut. C. E. Gillette, Corps of Engineers.

The continued high water of the summer and autumn of 1888 compelled the postponement of the extensive works of repair which had been proposed; but in May, 1889, through navigation was stopped, and active work was begun all along the river, special attention being given to the repair of the locks. The following is a summary of the work for the year:

At Lock and Dam No. 1 (Marietta) a leak above the dam was stopped, and a few stones that had washed out of the river-wall of the lock were replaced.

At Lock and Dam No. 2 (Devols) a broken guide-crib was removed from the head bay of the lock, and timber was accumulated to complete the repair of the dam, partly done in 1887.

At Lock and Dam No. 3 (Lowell) the lower ends of both lock-walls and part of the river-wall were torn down in June, 1889, preparatory to rebuilding. The original intention was to rebuild only the lower end of the lock, but after the walls were torn down it was found that the inner facing of the land-wall had separated from the backing, and that the whole of the river side of the lock-chamber needed reconstruction. In 1888 an abandoned mill-race near the head of the canal was filled up, and the cut stone of the inlet walls was removed for use in rebuilding the lock. A surveyor was employed to examine land-titles in this neighborhood, and he has discovered two tracts, previously unknown, that belong to the United States, and a third of which the ownership is uncertain.

At Lock and Dam No. 4 (Beverly) new upper gates with new hollow quoins and new operating gear have been placed in the lock and new guard-gates with new hollow quoins at the head of the canal. On the dam 80 feet of new work was placed in 1888, and a new masonry abutment, 70 feet in rear of the old abutment, was built. In June, 1889, work was begun to connect the dam with the new abutment and to remove the old abutment. Stone was also collected for the repair of the crib abutment at the lower end of the side or spill-dam.

At Lock and Dam No. 5 (Luke Chute) the joints of the lock were pointed and a coffer-dam was built and stone was accumulated for building a stone abutment. The work of building this abutment was begun in June, 1889.

In the pool above Dam No. 5 a large isolated rock, much in the way of navigation, was partly removed.

At Lock and Dam No. 6 (Stockport) preparations are being made to rebuild the lower buttresses of the lock. The crib on the ouside of the river wall, extending from the dam to the lower end of the wall, was carried away by high water during the winter. The joints in the abutment of the dam were pointed.

At Lock and Dam No. 7 (McConnellsville) new guard-gates were placed at the head of the canal and the joints of the abutment were pointed. The land-wall of this lock will be rebuilt during the next fiscal year.

At Lock and Dam No. 8 (Eagleport) preparations were made in 1888 for rebuilding the land-wall and the lower buttresses, but the continued high water made it impracticable. The coffer-dam is partly in and the work is now under way.

At Lock and Dam No. 9 (Taylorville) the head of the canal was dredged; the contractor for new Lock No. 9 has begun work.

At Lock and Dam No. 10 (Zanesville) the loose valves of the lock gates were fixed by a diver and the canal was dredged.

The dredge-boat *Malta* was accepted from the contractors in September, though not quite complete. She removed part of the bar at the head of the Taylorville Canal, dredged out 3,210 feet of the canal at Zanesville, and at the end of the fiscal year was at work in the McConnellsville Canal. As her spoil is discharged through an iron tube and is usually wasted it is not practicable to give the quantities of material handled, but under favorable circumstances she can discharge from 1,200 to 2,000 cubic yards in ten hours' work.

The dredge, as originally built, was defective in several particulars. By an error of the contractor, she could only dig to a depth of 8 feet, while the contract called for capacity to dig to a depth of 10 feet; this defect was remedied without expense to the United States. Experience showed that her discharge pipe, 20 inches in diameter and 48 feet long, was too small and too short for the kind of work required on the Muskingum, and the diameter of the pipe was increased to 28 inches, and its length was increased to 60 feet. The conveyor chain did not work satisfactorily, and it was deemed best to take it out and use a stronger jet of water in the hopper. These changes have been made, and it is believed that the dredge has been greatly improved, and is now well adapted to her work. She is practically a reduced copy of the Hercules type of dredges that have done such good work on the Panama Canal.

The little steam-boat "*Vega*" has been most useful in general service on the river; she has been furnished with a new boiler, the old one having become dangerous.

At the ship-yard at McConnellsville the upper gates for Lock 4 were completed, and lower gates were built for Lock 3, and guard-gates for the head of the McConnellsville Canal; two dump-scows and a quarter boat were built for the dredge, and one large flat for handling lock gates; three barges were repaired, and one barge was made over into a floating pile-driver; a carpenter shop and a machine shop were built; a water tank was set up in the yard; a wharf was built in the canal, and a supply of coal was received and stored.

As several of the locks are badly out of repair, necessitating the stoppage of navigation during reconstruction, it was decided to reduce the interference with navigation to a minimum by doing as much of this work as possible in a single season. During the low water of 1889, it is proposed to rebuild the lower end of Lock 3, the lower end of Lock 6, the lower end and land-wall of Lock 7, and the lower end, and as much more as can be completed, of Lock 8. The other proposed work, which can be done without stopping navigation, is to build a masonry abutment at No. 5, to repair Dam No. 4 and connect it with the new abutment, to complete the repairs of Dam No 2, and to do such minor work as may be practicable.

In repairing locks it is proposed to place the filling and emptying valves in the walls instead of in the gates, thus making the gates cheaper and stronger and keeping the gate recesses always free from mud. The filling valves will be cylindrical and the water will drop through vertical walls into a culvert extending across the lock above the upper miter-

wall, whence it will enter the lock chamber by culverts under this wall. The discharging valves will be vertical balanced valves of the usual type. As the stone in the Muskingum Valley is soft, the hollow quoins will be made of cast iron with concrete backing.

The new style of slope dam used in the repairs on the Muskingum River has proved very successful. The effect of the shape of the dam on the overflowing water is such as to throw the scour some distance below the dam, and in cases where pieces of dam of this shape have been inserted in old dams with deep holes just under them, these holes have at once filled up, so that in several cases on the river we now find low water depths of about 3 feet where there were formerly depths of over 20 feet.

As the Government apparently owns no land for lock-keepers' houses at Locks 5 and 8 it is proposed to purchase as much as may be required. There are several lock-keepers' houses needed, but it is advisable to let this matter lie over until the locks and dams are in a serviceable condition. During 1888, the river from Marietta to Dresden was carefully gone over by a leveling party under charge of Lieutenant Gillette and the levels of structures on the river were determined. As the Transcontinental Line of Levels of the U. S. Coast and Geodetic Survey crossed the Ohio at Parkersburg, a connection was made with their Belpre bench, and the levels of all points on the Muskingum River were thus connected with mean ocean level.

The results of this survey are given in the following table. I have added in a separate line the standard which will be maintained in all new work. It should be noted that "available length" is the maximum length that can be passed through a lock and is about 20 feet less than the distance between hollow quoins.

Muskingum River, Ohio.

Number.	Dam above mouth.	Location.	Lock.								Foundation.
			Available length.	Width.		Lift.	Upper sill below upper level.	Lower sill below lower level.	Guard.		
				Maximum.	Minimum.				Head.	Foot.	
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
		Standard	160	36	36	.....	6	5.5	.....	10	
	91	Dresden	.....	.....	.....	.....	.....	5.708	.....	.....	
11	85	Symmes Creek	104	21.2	21	8.1	4.9	4.3	10.1	6.1	Soft rock.
10	75	Zanesville	156	35.90	35.60	17.05	3.511	5.036	7.583	7.583	Rock.
9	65	Taylorsville and Duncan's Falls.	158	36.17	35.74	13.281	8.934	3.524	16.459	7.766	Do.
8	55	Eagleport	159	35.87	33.45	6 992	9.382	5.455	12.420	12.420	Gravel.
7	48	McConnelsville and Malta	157.4	36.06	34.80	11.138	9.235	2.661	11.530	6.684	Rock.
6	38	Stockport	158.8	36.30	34.50	11.049	9.121	3.527	13.749	7.420	Do.
5	32.5	Luke Chute	157.5	36.17	35.70	11.899	5.156	3.037	14.645	9.045	Do.
4	23	Beverly	157.5	36.08	35.10	10.424	8.470	3.775	13.988	7.729	Gravel.
3	12	Lowell	158.4	35.90	35.13	13.477	13.237	6.158	9.618	8.565	Do.
2	5	Devols	158	36.35	35.04	10.467	11.196	4.946	13.227	6.829	Rock.
1	0	Harmar	160	25.80	33.30	12.780	8.650	.200	13.249	7.920	Gravel.

Muskingum River, Ohio—Continued.

Number.	Location.	Dam.				Canal.	Elevations of lower ends of lock walls above mean ocean level.	Remarks.
				Abutment.				
		Length.	Foundation.	Right.	Left.	Length.		
	Standard	*Ft.*				*Feet.*		
	Dresden						707.52	Elevation of lower sill 693 659.
11	Symmes Creek	536	Gravel					In ruins.
10	Zanesville	514	Soft rock	Stone	Stone	3,940	695.53	Guard-gates on rock.
9	Taylorsville and Duncan's Falls.	850	Rock		do	5,260	678.67	Do.
8	Eagleport	525	Gravel	Crib			670.04	
7	McConnelsville and Malta.	472	Rock and gravel.	Stone	Crib	1,500	657.31	Guard-gates on timber.
6	Stockport	480	Rock	do			646.91	
5	Luke Chute	570	Rock and gravel.		Crib		637.49	
4	Beverly	465	do	Stone	Stone and crib.	2,575	625.27	Guard-gates.
3	Lowell	848	Rock	do	Stone	4,740	610.68	No guard-gates.
2	Devola	588	do	do			600.47	
1	Harmar	480	Gravel				591.09	

The above table shows the great lack of uniformity in the work as handed over to the United States. Omitting the old Symmes Creek lock, which was built before the general improvement of the river was undertaken, and lay above the main commerce of the river, we find that the available lengths of the locks vary from 157.4 feet to 160 feet, the maximum length of a boat being determined by the available length of the shortest lock; instead of the locks having a clear width of 36 feet, none of them have it, and one has a clear width of but 33.3 feet, which thus limits the width of boats to this minimum; the depths on the miter-sills follow no apparent law, varying for the upper miter-sills from 13½ to 3½ feet, and for the lower miter-sills from 6 feet to a little over 2½ feet, which latter depth limits navigation in low water. At Lock 1, the outlet into the Ohio from the Muskingum, there is at times less than 3 inches of water on the lower miter-sill. The guards at the lower ends of the locks limit navigation during high water, and the table shows that, while boats could pass through the Eagleport Lock when there was over 12 feet of water on the dam, they were stopped at Lowell when there was only 3½ feet on the dam; the State partly remedied this lack of height in the masonry of this lock by the addition of 2 feet of timber, but even after this addition it remained the lowest lock on the river.

It is worthy of note that the lifts of the locks, as determined by this survey, do not at all agree with those reported by the State authorities, as, for instance, Lock 8 was reported by them as having a lift of 8 feet 10 inches, whereas its actual lift is a trifle less than 7 feet.

It may be interesting to call attention to the fact that the top of the upper end of the lock at Zanesville, Ohio, is 2 feet 9 inches higher than the zero of the Monongahela gauge at Pittsburgh, or 3 feet 3 inches lower than the normal level of the pool of the Davis Island Dam.

During the year the Secretary of War, on the recommendation of this

office, established the following maximum water rates at the different dams on the Muskingum:

ANNUAL RATES FOR 1,000 CUBIC FEET OF WATER PER MINUTE.

Dam No. 1	$15	Dam No. 4	$24
Dam No. 2	12	Dam No. 6	36
Dam No. 3	24	Dam No. 10	60

Muskingum River leases for year ending April 30, 1899.

Location.	Lessee.	Dated.	Expires.
Dam 1, Marietta	Phœnix Mill Company	May 1, 1875	May 1, 1906
Do	Dircks & Bahlman	Feb. 15, 1879	Nov. 1, 1906
Do	do	do	Do.
Dam 2, Devola	Gates & Payne	Mar. 23, 1881	Mar. 23, 1911
Dam 3, Lowell	F. Wilking & Co	Nov. 1, 1873	Nov. 1, 1906
Do	Rechsteiner Bros	do	Do.
Do	E. W. Sprague	Dec. 12, 1879	Dec. 15, 1909
Dam 4, Beverly	C. R. Stull		
Do	H. C. Baldwin	May 11, 1875	May 1, 1906
Do	Mary L. Baldwin	Mar. 26, 1884	May 1, 1914
Do	D. T. Brown	July 13, 1886	July 13, 1916
Do	I. D. Spooner	Nov. 1, 1894	Nov. 1, 1914
Dam 6, Stockport	Pierrot & Lane		
Dam 10, Zanesville	Drone & Co	Dec. 7, 1871	Sept. 1, 1901
Do	Edward Johnson	Mar. 31, 1873	May 1, 1900
Do	Herman Harris & Co	Apr. 13, 1886	May 1, 1901
Do	Joseph Shaw	Sept. 6, 1881	Aug. 1, 1911
Do	Gary Bros. & Silvey	May 1, 1882	May 1, 1902
Do	do	Dec. 10, 1873	Nov. 1, 1906
Do	do	Nov. 20, 1867	
Do	Beaumont & Blankenbuhler	Oct. 6, 1885	May 1, 1907
Do	W. W. Miner	Aug. 30, 1887	
Symmes Creek	Sarah V. Plummer	Apr. 2, 1883	Apr. 2, 1889

Location.	Subject.	Cubic feet of water per minute.	Annual rental.	Rebate allowed.	Collected.
Dam 1, Marietta	Water-power*	3,000	$859	$146.39	$288.61
Do	do*	1,000	150		15.63
Do	Land		10		1.00
Dam 2, Devola	Water-power	1,200	175		175.00
Dam 3, Lowell	do	2,000	250		250.00
Do	do	750	100		100.00
Do	Land		5		5.00
Dam 4, Beverly	Water-power		225		225.00
Do	do	1,200	100		100.00
Do	do	1,200	100		100.00
Do	do	1,750	63		63.00
Do	do	600	75		75.00
Dam 6, Stockport	do		250		250.00
Dam 10, Zanesville	do		500		500.00
Do	do	6,100	400		400.00
Do	do	2,200	400		400.00
Do	do	750	150		150.00
Do	do	500	100		100.00
Do	Land		20		20.00
Do	do†		80		80.00
Do	Water-power	500	250		250.00
Do	Land‡		20		
Symmes Creek	do				1.80
Total					3,465.91

* Lease canceled.
† Revocable license.
‡ Revocable license. Licensee deceased and his estate bankrupt.

Detailed statement of expenses incurred for operating and maintaining the locks and dams on the Muskingum River for the fiscal year ending June 30, 1889.

GENERAL ADMINISTRATION.

Month.	Salaries.		Surveys.	Plant.			Buildings.	Supplies.	Transportation.	Miscellaneous.	Totals.
	Office force.	Lock-keepers, bridge-tenders, and watchmen.		First cost.	Repairs.	Hire.					
July	$495.00	$555.00	$242.69	$2,057.81	$154.44	.....	$10.59	$57.85	$1.55	$228.60	$3,723.53
August	458.34	570.00	64.50	2,575.73	199.24	$1.25	45.10	....	....	204.91	4,147.82
September	399.00	556.83	.....	6,088.37	374.30	1.25	164.69	39.40	....	185.06	7,808.92
October	481.66	570.00	319.36	276.88	128.40	74.75	.80	56.93	.....	165.38	2,006.66
November	484.17	570.00	378.44	70.56	208.29	1.25	106.57	35.53	1.00	183.79	2,039.10
December	420.00	571.50	320.88	291.50	10.28	.....	333.69	25.02	.....	124.91	2,099.61
January	420.00	570.00	2.74	13.75	25.83	.....	52.62	97.50	.....	76.67	1,259.20
February	420.00	570.00	.....	18.00	34.67	.....	138.75	22.76	.25	199.43	1,403.85
March	420.00	570.00	5.00	14.00	1.70	.....	.....	18.74	.....	66.28	1,090.72
April	507.50	570.00	.....	16.78	52.18	...	1.00	101.78	.75	151.59	1,401.58
May	505.00	570.00	.....	3,440.38	90.04	.....	2.06	47.28	26.00	167.08	4,937.86
June	431.66	570.00	.....	1,274.03	2.80	.....	.....	14.66	.....	63.87	2,357.02
Totals	5,472.33	6,813.33	1,333.61	16,137.79	1,282.15	78.50	855.89	513.13	29.55	1,777.59	34,293.87

United States dredge Malta.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	Totals.
September	$270.50	$388.02	$74.52	$63.65	$791.69
October	521.96	5.61	22.50	45.21	595.28
November	552.20	22.00	26.96	85.78	686.94
December	553.45	5.00	67.50	241.98	867.93
January	555.26	142.92	15.86	66.06	780.10
February	516.08	26.94	25.65	72.47	641.14
March	492.00	9.50	45.52	225.08	772.10
April	482.16	99.14	18.98	178.17	778.40
May	524.90	63.94	28.00	356.06	982.33
June	465.33	.....	.....	.....	465.33
Totals	4,943.84	768.07	325.44	1,334.46	7,861.81

Steamer Vega.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	Totals.
July	$362.58	$0.95	$100.29	$22.63	$486.45
August	360.75	19.68	26.87	3.05	410.35
September	358.75	.....	39.42	3.95	402.12
October	359.50	14.04	22.60	18.55	414.67
November	358.75	16.80	93.76	19.06	487.37
December	358.50	.....	28.88	7.20	394.58
January	111.33	1.15	.31	516.52	623.31
February	60.00	2.24	.....	2.70	64.94
March	60.00	.....	.....	5.58	65.58
April	327.99	25.46	32.64	113.17	499.26
May	357.48	.....	31.43	.....	388.91
June	357.50	.....	.....	.....	357.50
Totals	3,433.12	80.32	371.20	706.39	4,591.04

Repair of locks and dams.

Month.	Lock and Dam No. 1.				Lock and Dam No. 2.			
	Labor.	Material.	Boat-hire.	Totals.	Labor.	Material.	Boat-hire.	Totals.
July	$270.62	$224.29		$494.91	$82.20	$204.23		$286.43
August	158.33	3.00		161.33				
September	5.00			5.00				
October		7.00		7.00				
November					12.46			12.46
December	113.28	3.93		117.21				
January	12.60			12.60		1,215.11		1,215.11
February								
March						.25		.25
April	16.24			16.24				
May					142.66	1,264.76		1,407.42
June	169.46			169.46				
Totals	745.53	238.22		983.75	217.32	2,684.35		2,901.67

	Lock and Dam No. 3.				Lock and Dam No. 4.			
July		$2,831.81		$2,831.81	$588.77	$2,204.94		$2,793.71
August	$17.33	90.95		108.28	1,475.53	888.72	$19.00	2,383.25
September	134.44	11.72		146.16	3,009.49	452.47	60.00	3,521.96
October	468.36	563.83	$15.00	1,047.19	3,573.53	2,071.39	366.00	6,010.92
November	423.32	.90	15.00	439.22	3,041.83	675.39	83.00	3,800.22
December	15.57		6.50	22.07	1,366.12	429.54	93.00	1,888.66
January						97.16		97.16
February	7.00	41.05		48.05		41.04		41.04
March					48.48	443.33		491.81
April	396.04	1,267.82		1,663.86	137.49	2,126.85		2,264.34
May	1,873.96	1,058.94		2,932.90	1,290.46	567.40		1,857.86
June	2,930.56			2,930.56	1,885.68	588.43		2,474.11
Totals	6,266.58	5,867.02	36.50	12,170.10	16,417.38	10,586.66	621.00	27,625.04

	Lock and Dam No. 5.				Lock and Dam No. 6.			
July	$5.04	$182.90		$187.94		$185.40		$185.40
August	142.46			142.46		688.00		688.00
September	89.28	138.93		228.21	$75.00			75.00
October	144.49			144.49				
November					188.65			188.65
December								
January	309.93	6.30		316.23				
February		41.04		41.04		41.04		41.04
March								
April	368.89	45.25		414.14		2.00		2.00
May	1,056.60	628.67		1,685.27	284.64	739.17		1,023.81
June	831.37	475.46		1,306.83	1,323.33			1,323.33
Totals	2,948.06	1,518.55		4,466.61	1,871.62	1,655.61		3,527.23

	Lock and Dam No. 7.				Lock and Dam No. 8.			
July	$1,159.29	$548.38		$1,707.67		$2,844.00		$3,844.00
August	1,252.95	7.00		1,259.95	258.54	201.70	$16.00	476.24
September	382.50	9.00		391.50	1,905.24	1,881.63	60.00	3,846.87
October	568.33	1.00		569.33	1,798.28	266.28	202.00	2,266.56
November	488.23	12.50		500.73	1,239.33	149.15	58.00	1,446.48
December	802.64	527.13		1,329.77	106.85	302.70	4.00	415.55
January	1,011.73	112.25		1,123.98		14.62		14.62
February	141.91	2.00		143.91		39.04		39.04
March	57.58			57.58	10.92			10.92
April	119.00	22.25		141.25	73.50	24.00		97.50
May	1,637.11	271.35		1,308.46	996.15	1,074.63		2,070.78
June	1,276.85			1,276.85	2,054.87	484.92		2,539.79
Total	8,298.12	1,512.86		9,810.98	8,445.68	7,283.27	340.00	16,068.95

Repair of locks and dams—Continued.

	Lock and Dam No. 9.				Lock and Dam No. 10.			
July	.....	$217.73	.....	$217.73	$47.63	$183.90	.....	$231.53
August	$5.58	.....	.....	5.58	29.73	70.00	.....	49.43
September	24.14	.....	.....	24.14	99.47	3.50	.....	102.97
October	2.18	.....	.....	2.18	21.96	11.16	.....	33.12
November	3.32	1.55	.....	4.87	42.48	1.82	.....	44.30
December	.....	20.24	.....	20.24	44.19	2.73	.....	46.92
January	.....	.....	.....	.....	48.35	4.54	.....	52.89
February	.....	.....	.....	.....	30.19	50	.....	30.69
March	.....	.....	.....	.....	29.10	.....	.....	29.10
April	.....	.....	.....	.....	83.44	8.00	.....	91.44
May	.....	.....	.....	.....	32.68	41.87	.....	74.55
June	.....	.....	.....	.....	62.50	.....	.....	62.50
Totals	35.22	239.52	.....	274.74	581.72	258.72	.....	840.44

Summary.

General administration	$34,293.87	Lock and Dam—	
United States dredge *Malta*	7,361.81	No. 6	$3,527.23
United States steamer *Vega*	4,591.04	No. 7	9,810.98
Lock and Dam—		No. 8	16,068.95
No. 1	983.75	No. 9	274.74
No. 2	2,901.67	No. 10	840.44
No. 3	12,170.10		
No. 4	27,625.04	Total	124,916.23
No. 5	4,466.61		

Estimate for fiscal year ending June 30, 1890.

Lock and Dam No. 1—Marietta:		Repair of dam	$600
Repair of dam	$500	Lock and Dam No. 7—McConnelsville:	
Lock and Dam No. 2—Devols:		Repair of lock	25,000
Repair o dam	4,000	Repair of dam	5,500
Repair of lock-wall	1,200	Lock and Dam No. 8—Eagleport:	
Lock and Dam No. 3—Lowell:		Repair of lock	40,000
Repair of lock	16,000	Repair of dam	2,000
New lower gates and repair of upper gates	2,800	Lock and Dam No. 10—Zanesville:	
Repair of dam	2,500	Retaining-wall at head of canal	888
Lock and Dam No. 4—Beverly:		Repair of right abutment	700
Repair of lock	6,000	Repair of dam	1,000
New lower gates	1,600	Salaries of lock-keepers	7,020
Repair of dam	11,500	Steam-boat *Vega*	4,500
Extension of right abutment	2,200	Dredging	15,000
Lock and Dam No. 5—Lake Chute:		Clerks and draughtsmen	5,920
Repair of lock	7,600	Rents, fuel, gas, and water	420
New lower gates	1,600	Surveys	1,200
Repair of dam	6,000	Contingencies	8,000
New abutment	5,000		
Lock and Dam No. 6—Stockport:		Total	221,248
Repair of lock	35,000		

Abstract of proposals for dimension and backing stone for repair of locks and abutments on Muskingum River, opened at Zanesville, Ohio, March 21, 1889.

No.	Name and address of bidder.	Dimension stone, price per cubic yard.	Backing stone, price per cubic yard.	Aggregate.
	Stone to be delivered at Lowell, Ohio.			
1	E. B. Henderson & Son, Marietta, Ohio	$3.67	$3.67	$4,954.50
2	L. M. Petitdidier, Cincinnati, Ohio	4.44	3.44	4,994.00
3	W. A. Snodgrass, Marietta, Ohio	4.50	3.45	5,025.00
4	William Loffland, Harmar, Ohio	4.97	4.23	5,969.50
5	T. B. Townsend, Zanesville, Ohio	5.00	5.00	6,750.00
6	C. I. McDonald, Pittsburgh, Pa	6.00	5.50	7,600.00
	Stone to be delivered at Stockport, Ohio.			
1	E. B. Henderson & Son, Marietta, Ohio	3.67	3.67	4,954.50
2	L. M. Petitdidier, Cincinnati, Ohio	4.44	3.44	4,994.00
5	T. B. Townsend, Zanesville, Ohio	4.00	4.00	5,400.00
6	C. I. McDonald, Pittsburgh, Pa	6.00	5.50	7,600.00

Contract awarded to E. B. Henderson & Son and executed under date of April 11, 1889.

REPORT OF LIEUTENANT LANSING H. BEACH, CORPS OF ENGINEERS.

Owing to the time at which the funds for the river became available, about the middle of August, and to the continued high water and numerous freshets after that date, it was impossible to carry to completion much of the work contemplated for the season of 1888.

At No. 1 a large leak developed through the stone filling with which the break in the dam had been closed the previous summer. It was repaired early in July by having the Ohio River dredges dig out a portion of the coarse material and filling the excavation thus made with gravel, which formed a better backing for the dam and more effectually prevented the passage of water.

At No. 2 an old timber crib at the head of the land-wall of the lock fell down about the middle of July, and interrupted navigation for about one day until the débris could be removed. It has not been rebuilt, being considered unnecessary.

At No. 3 the season's plan contemplated rebuilding the lower end of the lock, which was in an extremely dilapidated condition, and some work was done in gathering materials and in general preparation, but the unfavorable stage of the river made it evident that if the walls were demolished the lock could not be again placed in navigable condition without extending the work into another season, and, as the pressure for all available plant at more dangerous points was very great, operations were suspended here in October.

At No. 4 it was proposed to rebuild the old portion of the dam, about 300 feet in length, to build a new abutment about 70 feet inland from the old abutment, which threatened to go out at any time, and to extend the dam by the distance between the two. Work on the dam was begun as soon as funds were available, and the material being on hand good progress was made, but on the night of August 21 a heavy and sudden rise in the river carried away all that had been done to that time, about 80 feet of dam foundation already in position being swept into the Ohio, and it was only by great exertions that a large portion of the material on the bank was saved. Operations on the dam were so frequently interrupted by high water that at the end of the season all that had been possible was to build a section 80 feet long; the rest of the dam could not be built, in spite of all efforts, although work was continued until it became dangerous. One boat was carried over the dam—fortunately over the new or slope part—and no lives were lost.

The land for the new abutment and extension of the dam was donated for the purpose by Miss Charlotte Hayward, on condition that the Government should prevent further wash of the bank below, which also belonged to her. This abutment was not finished until about the middle of December, owing to the interruptions from high water, and it was only by the greatest efforts and the concentration of engines and pumps at this locality that the foundation was completed in the latter part of November.

The upper gates of the lock, which were so badly decayed, broke down completely in October, but as new gates were on the way at the time to replace them the delay to navigation was short. New guard-gates were placed at the head of the canal a little earlier in the same month.

At No. 8 it was the plan to rebuild both ends of the lock and the larger part of the land-wall. This work offers exceptional difficulties, owing to the character of the soil upon which its foundation must rest, together with the fact that it is full of springs, while the coffer is exceedingly hard to construct, the outside lower corner being in 27 feet of water. It required some three months' work, with the numerous interruptions from floods, to build that portion of the coffer below the dam and parallel to the lock-wall. This part was finished in November and placed in as good condition as possible to stand the winter, and work was then suspended in order to allow all efforts to be concentrated at No. 4. A large amount of stone was out, and other material accumulated.

During the present season active operations were resumed as early as practicable at the various points where it was suspended the fall before.

At No. 3 the lock has been inclosed by coffers and the lower ends of both walls have been removed nearly to the foundation. As soon as the work of demolition had been fairly begun a new and unexpected defect was exposed; the face of the river-wall of the lock has separated from the body of the wall along the line of the back of the stretchers, all the headers being broken off, and the entire front of the wall has moved forward several inches until it is now in an extremely dangerous condition; should it fall with a boat in the lock the vessel would certainly be crushed. The walls of this lock were raised somewhat over two feet by timber backed with earth, which explains why the rupture was not visible in the coping. The face of this wall will have to be rebuilt, which will considerably increase the expense for this lock. Work has been interrupted somewhat by one of the town sewers which was found emptying into the lock. Its course is now being changed, and no further trouble is anticipated from that source.

At No. 4 work was begun early in May upon the extension of the dam, the plan for the present season being to begin at the new abutment and work towards the middle of the river. The toe of the dam was quite difficult to place, owing to the necessity of excavating under water among large stones and trees where a dredge could not work on account of numerous broken piles which it was impossible to pull. The foundation is now in, however, for the larger part of the extension and future progress will probably be more rapid.

At No. 5 the work of building a new abutment has been actively begun and the materials, except a small portion of stone, being on the ground ready for use, it is proposed to put in the foundation without building a coffer, which is considered inadvisable, owing to the great depth of water below the dam, over 30 feet. The brush and stone dam, to protect the excavation from the water of the upper pool, is completed, and considerable progress has been made in removing that portion of the dam covering the site of the abutment.

At No. 6 the present plan is to rebuild as much of the lock as the season will permit; the coffer is nearly completed, but work is much delayed by the contractor's failure to deliver stone.

At No. 8 the coffer has been completed, and the work of demolishing the lower end of the lock begun. A split in the river-wall similar to that at Lowell has been discovered, but it is believed that the defect is not of such serious extent as at that locality. As far as ascertained, it reaches to a point 20 or 25 feet above the lower gate recess, and from about 15 feet below the top of the wall to the bottom.

At No. 7 work was almost continuous throughout the year, owing to this being the place where the store-yard and ship-yard for the river is located. Two dump-scows and a quarter-boat for use with the dredge *Malta* were built here, also a large decked barge for general services; four barges and a pile-driver were repaired, while considerable work was done in making tram-cars, derricks, dump-boxes, and other plant, as well as in general repairs. The lower gates of Lock No. 3 have just been finished here, and others are in process of construction. A carpenter shop, which was much needed, has been built.

The dredge *Malta* was provisionally accepted from the contractors in September, and continued to work until the latter part of February in the Zanesville canal, except when interrupted by high water, and for a period of two weeks when removing a bar at the head of the Taylorsville canal. The dredge was idle during the month of March and for the larger part of April, receiving a new discharge-pipe and undergoing minor changes. It was laid up during May on account of the breaking of the ladder-frame, but is again in working condition and engaged at the head of the McConnelsville canal. The width of the cut made by the dredge, over 50 feet, and the method of discharging the spoil, make it an economical excavator for the lateral canals of the Muskingum.

The Government steamer *Vega* has been of the greatest advantage to all the works, and has been engaged mainly in general towing and handling barges at the different localities. Its efficiency has been greatly increased by a new boiler, but it is too small a boat to render the desired service upon the river at all stages of water.

In accordance with the provisions of the last river and harbor act, the commissioners of Washington County have been notified to have the Beverly and Waterford bridge across the Muskingum, and the lower bridge across the Lowell Canal placed in such condition as to be easily navigable by the first of November, 1899. Similar notices have been served upon the commissioners of Muskingum County regarding the Fifth Street Bridge across the river, and the Main Street Bridge over the canal, both in Zanesville.

A regular system of rentals for water leases has been established, based upon the relative value of the privilege at the various localities. The changes during the year were as follows: New leases were issued to Beaumont & Blankenbuhler, and to Edward Johnson, at Zanesville; to Joseph Newberry, at Stockport; to Robbins Brothers, and to Stull & Jumper, at Beverly; and to Gates & Payne, at Devola. The leases of Herdman, Harris & Co., William Miner, at Zanesville, and of Dircks & Bahlman, at Marietta, were canceled by the Secretary of War upon the lessees' applications, and the lease of Sarah V. Plummer, at Symmes Creek, expired by limitation.

The Zanesville and Ohio River Railroad has not yet secured the right of way across the Government land at Malta.

Of the things done during the previous year the effect of a few surpasses expectation. It is found that the form of slope-dam adopted upon the river causes a fill immediately below the dam itself and pushes the deep hole which formerly existed at the dam to a distance of about 100 feet down stream. In every case where this form was used the depth at the dam is now from 2½ to 3 feet, while before construction the depth varied from 10 to 27 feet at the different localities.

The mud-sluices put in Lock No. 9 have kept it perfectly free from mud, and not the

slightest trouble has been experienced here from this cause, which at other points at times almost interrupts navigation.

The walls of Lock No. 9, which were faced with concrete, have stood the effect of two winters without suffering the slightest damage, and are to-day as perfect as the day the work was finished.

Commerce of Muskingum River during the fiscal year ending June 30, 1889.

Month.	Lock No. 1.					Lock No. 2.				
	Steamboats.	Barges.	Miscellaneous.	Total.	No. of lockages.	Steamboats.	Barges.	Miscellaneous.	Total	No. of lockages.
July	69	24	20	113	101	69	21	19	109	103
August	23	13	20	56	54	74	7	12	93	79
September	45	8	16	69	69	81	9	1	91	91
October	59	13	17	89	88	77	11	5	93	83
November	85	22	9	116	108	89	9	3	101	98
December	53	16	7	76	74	72	10	1	93	93
January	47	5	4	56	56	73	4	0	77	77
February	11	1	0	12	12	20	1	0	21	21
March	84	13	15	112	112	95	12	3	110	107
April	95	7	57	159	159	103	8	2	113	113
May	82	24	33	139	138	104	30	5	139	133
June										
Total	653	146	198	997	971	857	122	51	1,030	1,007

	Lock No. 3.					Lock No. 4.				
July	54	25	3	82	82	62	16	4	82	78
August	49	5	5	59	57	60	14	4	78	68
September	49	5	5	59	59	60	39	3	102	86
October	69	3	4	76	76	49	28	0	77	65
November	87	8	2	97	95	52	11	4	67	60
December	57	3	0	60	60	33	3	2	38	37
January	73	0	0	73	73	22	3	2	27	27
February	20	1	0	21	21	4	1	0	5	5
March	98	11	5	113	109	44	2	1	47	47
April	103	8	0	111	111	64	9	0	73	69
May	93	22	4	119	111	96	50	5	151	139
June										
Total	722	91	28	871	854	546	176	25	747	683

	Lock No. 5.					Lock No. 6.				
July	61	4	2	67	66	63	4	4	71	71
August	70	47	3	120	88	66	13	4	83	83
September	56	30	4	90	71	54	22	7	83	79
October	76	34	7	117	98	75	20	12	107	100
November	53	7	3	63	55	54	7	4	65	60
December	36	10	0	46	39	36	6	2	44	40
January	22	0	1	23	23	22	0	1	23	23
February	4	0	0	4	4	4	0	0	4	4
March	46	0	2	48	48	46	0	4	50	50
April	58	17	0	75	72	56	14	2	72	65
May	80	32	5	117	94	76	35	11	122	104
June										
Total	562	181	27	770	658	552	121	51	724	670

Commerce of Muskingum River during the fiscal year ending June 30, 1889—Continued.

	Lock No. 7.					Lock No. 8.				
July	68	4	4	76	75	120	10	7	137	132
August	68	8	7	83	76	120	33	10	163	140
September	52	23	13	87	77	104	43	6	153	141
October	71	20	14	105	97	114	35	5	154	144
November	56	10	2	68	64	110	19	6	135	126
December	38	14	3	55	50	68	9	3	80	75
January	23	4	0	26	26	43	1	2	46	46
February	4	0	0	4	4	4	0	0	4	4
March	46	2	4	52	52	90	9	1	100	95
April	57	16	8	81	73	111	24	2	137	128
May	62	41	8	111	97	106	30	10	146	123
June										
Total	544	141	63	748	691	990	213	52	1,255	1,164

	Lock No. 9.					Lock No. 10.				
July	118	10	4	132	127	113	0	2	115	114
August	104	19	7	130	114	105	7	1	113	110
September	94	14	7	115	109	86	2	9	97	96
October	107	7	6	120	117	109	6	1	116	112
November	97	7	5	109	103	94	2	3	99	96
December	66	5	2	73	67	68	3	6	77	73
January	43	5	2	50	48	42	0	0	42	42
February	4	0	0	4	4	4	0	0	4	4
March	90	5	9	104	100	90	0	2	92	92
April	106	5	4	115	111	107	6	2	115	112
May	109	8	10	127	117	102	0	5	107	105
June										
Total	938	85	56	1,079	1,017	920	26	31	977	955

SUMMARY.

Locks.	Steamboats.	Barges.	Miscellaneous.	Total.	No. of lockages.
No. 1	653	146	198	997	971
No. 2	857	122	51	1,030	1,007
No. 3	752	91	28	871	854
No. 4	546	176	25	747	682
No. 5	562	181	27	770	658
No. 6	552	121	51	724	670
No. 7	544	141	63	748	691
No. 8	990	213	52	1,255	1,164
No. 9	938	85	56	1,079	1,017
No. 10	920	26	31	977	955
Total	7,314	1,302	582	9,198	8,669

D D 10.

PRELIMINARY EXAMINATION OF HARBOR AT OWENSBORO, KENTUCKY.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 7, 1889.

GENERAL: I have the honor to submit the following report on the preliminary examination of "harbor at Owensboro, Ky.," as required by the river and harbor act of August 11, 1888.

As far as navigation is concerned there is nothing whatever the matter with the harbor of Owensboro, as there is sufficient water for boats at all stages of the Ohio River. The object which is desired by those at whose instance this item was inserted in the river and harbor

act is to get the General Government to pave or otherwise protect the front of the town. Work of this character on the Ohio River has hitherto been done by the towns themselves or by the riparian owners, and I can not see any reason that would justify a recommendation that work at this particular locality should be made exceptional and should be paid for out of the national Treasury. The wash of the banks is slight in amount and easily controlled, and it can continue indefinitely without the probability of affecting navigation in the slightest.

This matter was once before called to my attention, and in my report of October 14, 1884 (Report of Chief of Engineers, 1885, page 1831), I stated that the locality was not worthy of improvement. Nothing has occurred since that time to change my opinion, and it is therefore my duty to again report that the locality is not worthy of improvement and that no survey is needed.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

D D 11.

PRELIMINARY EXAMINATION OF MONONGAHELA RIVER ABOVE UPPER DAM, WEST VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 7, 1889.

GENERAL: I have the honor to submit the following report on the preliminary examination of "Monongahela River above upper dam," as required by the river and harbor act of August 11, 1888.

The "upper dam" on the Monongahela River is evidently Dam No. 9, at Hoard's Rocks, which ponds the river to Morgantown. The locality to be examined is therefore the Monongahela River above Morgantown, W. Va.

The river and harbor act of March 3, 1875, ordered a survey of this river from Morgantown to Fairmont, and my report on this survey, dated December 11, 1875, is printed in the Annual Report of the Chief of Engineers for 1876, Part II, page 129. For a detailed description of the river and its slope I would refer to this report and its accompanying maps.

Since that report was written the lock and dam (No. 9) at Hoard's Rocks has been finished, and the lock and dam at Dunkard's Creek (No. 8) is so nearly finished that one more season will open it to navigation, thus completing the continuous water-line from Pittsburgh to Morgantown.

My former report contemplated six more dams, extending slackwater several miles above Fairmont, in order to reach the heavy deposits of excellent coal on the West Fork. The only change which I would now make in the report is to increase the average cost of a masonry lock and dam to $200,000, as this is about the cost of the work at Hoard's Rocks. If contracts could be made at one letting for a complete lock and dam the total expenditure could be considerably reduced, but on the supposition that future appropriations will be made as past ones have been, it is not safe to calculate upon a smaller expenditure than that which I have named.

The work of extending the existing slackwater should begin at Morgantown and continue up-stream to Fairmont. The exact location of each lock can better be determined after an appropriation has been made for its construction.

The probable amount of commerce to be benefited by this improvement can not be stated with accuracy, but the fact that there is an immense coal trade on the Lower Monongahela River (details of which can be seen in my annual reports) and a considerable passenger and freight business justifies the prediction that similar commerce will develop on the Upper Monongahela River when similar facilities are given. The coal trade will not attain large dimensions until the coal fields within reach of the lower pools are exhausted, but when that time comes the great deposits of the West Fork will be needed by the consumers of the Ohio and Mississippi valleys, and the proposed locks and dams will create the only route to market that can be used with profit.

I would conclude by stating that in my judgment the locality is "worthy of improvement," but that no "survey" is now needed, since the one made in 1875 is considered as sufficient.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

D D 12.

PRELIMINARY EXAMINATION OF CHEAT RIVER, WEST VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 7, 1889.

GENERAL: I have the honor to submit the following report on the preliminary examination of "Cheat River, West Virginia," as required by the river and harbor act of August 11, 1888.

Cheat River is one of the principal tributaries of the Monongahela River, which it joins at Point Marion, 1½ miles north of the southern boundary of the State of Pennsylvania. It rises in Randolph County, W. Va., on the eastern slope of the Cheat Mountain (one of the ranges of the Allegheny), and is remarkable for its four parallel forks—Shaver's, Glade, Laurel, and Dry. The total length of Cheat River is about 140 miles, of which distance the upper 90 miles has a gentle slope and is fairly adapted to rafting, while the lower 50 miles, lying below the town of Rowlesburg, on the Baltimore and Ohio Railroad, is almost impassable. In this distance the river cuts through Laurel Ridge, and the river-bed is not only steep, but is filled with huge bowlders, that have fallen from the sides of the mountain. For details of the condition of affairs I would refer to the annexed report of Mr. Charles E. Rees, assistant engineer, who made a careful examination of the river between Rowlesburg and its junction with the Monongahela at Point Marion.

Nearly the whole region above Rowlesburg is a virgin forest, filled with the finest white oak, spruce, pine, cherry, and other valuable timbers, that are now going to waste for lack of facilities for transportation to markets. In the valleys of the Monongahela and the Ohio there is a growing scarcity of good white oak for coal barges, lock-

gates, dams, spars, derricks, dredge-spuds, and other purposes, and the small amount of money required to open up a safe logging channel through the obstructed part of the Cheat River would soon be repaid a thousand fold. I have a strong personal feeling in the matter, on account of the great difficulty I have experienced in getting suitable timber for the lock-gates at locks 8 and 9, on the Monongahela River, while I know that millions of feet of exactly the timber needed are growing on the Cheat River that could have been rafted directly to the locks in question had the river been reasonably clear of obstructions.

The estimated cost of such work as is immediately necessary is $13,000, all of which is to be expended in blasting and removing rock. After this is done the channel will be sufficiently smooth to develop its capabilities, and the question of further improvement by closing duplicate channels and similar work can then be determined by the results of the work herein indicated.

I have therefore to report that Cheat River is decidedly "worthy of improvement" to the extent and for the purposes named, and that no "survey" is required, as the preliminary examination has developed all necessary facts.

Respectfully, your obedient servant,

W. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. CHAS. E. REES, ASSISTANT ENGINEER.

November 28, 1888.

SIR: I have the honor to submit the following report of an examination of Cheat River, from Rowlesburg, W. Va., to its mouth at Point Marion, Pa., a distance of 49¼ miles.

The commercial importance of this river depends upon its capacity for transporting timber from the forests of West Virginia to the markets along the Monongahela and Ohio rivers.

From the headwaters of the river to Rowlesburg this timber can be transported in rafts, but from this point to Beaver Hole, a distance of 33¾ miles, this method of navigation is impracticable on account of numerous rocks and rocky bars which would break up the rafts. As a consequence only such timber as is required for the mills at and above Rowlesburg (about 10 per cent. of the product) is made up into rafts, while the balance is either "drifted" (that is, turned loose in the stream to be carried down by the current) or "driven" (that is, followed in their course and pushed into the channel whenever lodged upon rocks or shore bars) to the Beaver Hole, in which pool such of the logs as are to go beyond the mouth of the river are gathered together and made up into rafts, while those destined for the mills between this place and Point Marion pass down singly to the booms at the various mills.

I am informed by the principal lumbermen of the region that from Rowlesburg to Beaver Hole, owing to the precipitous banks which in high stages do not furnish a foot-hold for the drivers, the process of drifting is the only available method of transportation; this is the cause of great inconvenience and delay, from the fact that the logs become lodged and jammed at various points, and are sometimes delayed two or three years in reaching their destination, and frequently rot where they are stranded. It is the general opinion that if the channel, for a width of, say, 50 feet, were cleared of obstructions, the great majority of the drifted logs would reach their destination on a single rise, the cost of handling stranded logs would be greatly reduced, and the total loss of logs that become immovably jammed would be almost wholly obviated.

The points which need immediate attention are as follows:

Calhoun Island, 2¼ miles below Rowlesburg. This island is about 400 feet long, the main channel, 125 feet wide, being on the left side; the trouble at this place comes from the fact that in high water many logs are drawn into the narrow chute on the right, and are stranded on the head of the island and upon the shore opposite.

Buck Horn Ripple, 3¼ miles below Rowlesburg. This is at the head of what is known as the narrows, and is the first of the serious obstructions; about 450 cubic yards of rock obstructions should be removed at this point, and about 240 cubic yards of detached bowlders should be taken from the shores within the first half-mile below.

Hickory Bear-Pen Run, 4¼ miles below Rowlesburg. A wide bar, covered with bowlders, projects from the left bank just below the mouth of this run, forcing the channel to the right. The channel is much obstructed by bowlders, rendering it impassable except in high water. A crib-dike from the left bank, constructed by lumbermen to close a troublesome chute across the bar and to deflect the logs into the proper channel, has been entirely washed away.

Rock to be removed at this point, 370 cubic yards.

Between Hickory Bear-Pen Run and Shanty Run, a distance of three-fourths of a mile, are found many scattering bowlders, aggregating 970 cubic yards, which should be removed.

Shanty Run Bar, 5¼ miles, and *Bear Wallow Run Bar*, 6 miles below Rowlesburg. The current for a distance of 500 feet at the first-named bar is very rapid, and the passage of logs is difficult on account of bowlders which cover the bar on the right and greatly obstruct the main channel; the narrow chute between this bar and the right bank, which is dry at low water, is also troublesome in drifting stages. From these two bars and the intervening pool it is necessary to remove about 810 cubic yards of rock obstructions.

Commencing at a point 500 feet below Bear Wallow River Bar the current is very rapid for about a quarter of a mile, and is much obstructed; about one-half mile below another bar occurs, where the river is very narrow, the channel, on the left, being not over 50 feet in width, with a chute 30 feet wide on the right. From these rapids and the bar below about 1,470 cubic yards of rock should be removed.

Oil Mill Run, 7 miles below Rowlesburg. Near the mouth of this run another bowlder bar extends nearly across the river, and for a distance of 1,500 feet the current is very rapid and is much obstructed by rocks.

Rocks to be removed, about 1,000 cubic yards.

Pringle Run, 7¼ below Rowlesburg. Six large bowlders and numerous smaller ones, aggregating about 440 cubic yards, should be removed. About 180 cubic yards should also be taken out to destroy a pocket near the foot of the narrows, 8 miles below Rowlesburg.

From the foot of the narrows to Morris Island, 2¼ miles, the river is free from obstructions. At Trowbridge Ferry, one-fourth mile below the foot of the narrows, the river is about 350 feet wide, with a depth of 6 feet in the channel at low water.

Morris Island, 10¼ miles below Rowlesburg. This island is about 1,500 feet long, the main channel, 150 feet wide, being on the right, with a narrow chute on the left. The principal difficulty is that, during high stages, the logs are drawn into the chute and there stranded. A dam about 200 feet long is needed to close this chute.

Mason's Ripple, 12¼ miles below Rowlesburg. For a distance of 600 feet on this ripple the river is about 125 feet wide and very rapid; about 75 cubic yards of stone should be removed to facilitate the passage of logs.

From this point to Albright's, 2 miles, thence to the head of McKnight's Island, 1¼ miles, and thence to the mouth of Muddy Creek, one-half mile, the channel is clear of obstructions.

Muddy Creek, 16¼ miles below Rowlesburg. About 75 cubic yards of rock obstruction should be removed from the bar near the mouth of this creek.

Small Falls, 16¾ miles below Rowlesburg. These falls, one-fourth mile long, are at the head of the "Rapids," which are about 15 miles in length. The channel is greatly obstructed by large bowlders, the estimated quantity requiring removal being about 1,000 cubic yards; 630 cubic yards should also be taken from the channel within the distance of 1¼ miles below.

Great Falls, 18¾ miles below Rowlesburg. This is the most dangerous place in the river, the current for one-fourth of a mile being exceedingly rapid, and the channel being greatly obstructed by large pieces of detached rock and immense bowlders rising from 20 to 30 feet above the water. About 935 cubic yards of rock should be taken out at this place.

Green Island, 20¼ miles below Rowlesburg. This island is about 1,200 feet long, and is covered with bowlders at its upper end, while a narrow chute between the island and the left bank also causes much trouble; two thousand logs were stranded at this place during the last rise in the river. A portion of the obstructions have already been removed by private parties, but it is still necessary to remove about 270 cubic yards of stone, which should be used in closing the chute.

Between Green Island and a point 3¼ miles below, the river is narrow, and the removal of 1,790 cubic yars of stone is necessary.

Barker's timber chute, 24¼ miles to *McMullen's timber chute*, 27¼ miles below Rowlesburg. Between these two chutes, by which logs are shot down from the mountain,

there are three very rapid places, varying in length from 60 to 100 feet, and obstructed by large bowlders, requiring the removal of 600 cubic yards of stone.

Sackett's Harbor, 27¼ miles below Rowlesburg. Six large bowlders form a very large troublesome pocket at this place, in which logs have at times remained for years; 310 cubic yards of rock should be removed.

Between Sockett's Harbor and the mouth of *Sandy Creek*, a distance of 1¼ miles, about 100 cubic yards of rock should be removed from the middle of the stream.

Devil's Den, 29¼ miles below Rowlesburg. Eight large bowlders form a pocket on the right of the main channel, which is very troublesome; 205 cubic yards of stone should be removed. From this place to the mouth of *Bull Run*, one-half mile, and thence to Short Ripple, one-half mile further, the river is free of obstructions.

Short Ripple, 30¼ miles below Rowlesburg, 15 cubic yards of rock should be removed.

Bee Run Ripple, 31¼ miles below Rowlesburg, 60 cubic yards of rock should be removed.

Beaver Hole, 33¼ miles below Rowlesburg. This is a pool at the foot of the rapids, about 1,200 feet long and 600 feet wide, in which, as before stated, such logs as are intended for the markets below the mouth of the river are collected and made up into rafts. The stage of water at this place at the time of examination (November 20) was 6½ feet; a stage of 8 feet is considered available for rafting. About 10 cubic yards of rock should be removed from the foot of the pool.

Laurel Island, 34½ miles below Rowlesburg. This island is about 1,200 feet long, with a good channel on the left, and a chute about 30 feet in width on the right. No obstruction except at a stage above 15 feet.

The Whirlpool, 34¼ miles below Rowlesburg. About 30 cubic yards of rock should be removed at the foot.

Grassy Island, 36¼ miles below Rowlesburg. A few large bowlders should be removed just above the island; otherwise no obstruction is found, there being plenty of water on either side of the island.

One-half mile below the head of Grassy Island several large bowlders extending nearly to the middle of the stream should be removed—130 cubic yards.

Quarry Run Bar, 38¼ miles below Rowlesburg, 15 cubic yards of rock should be taken from the bar on the right.

From this place to Ley's Mill (one-half mile), where there is a large island with the channel on the left, and thence to Forge Island (1 mile) there are no obstructions.

Forge Island, 39¼ miles below Rowlesburg. The main channel is on the left of the island, the chute on the right being closed by a mill-dam at the foot. The island is also divided by a middle chute which is never used. Messrs. Huling & Co. have built a crib fender, about 6 feet high, at the head, to keep the logs off of the island, and to force them into the channel on the left. No obstruction except at a stage exceeding 15 feet.

Rood Island, 40¼ miles below Rowlesburg. This island is about one-half mile long with a channel 250 feet wide on the right. It is also crossed by numerous chutes from right to left. A crib fender has been built by Messrs. Huling & Co. at the head of this island. No obstruction except at stages exceeding 12 or 15 feet.

From Rood Island to *Stafford's Eddy*, one mile, thence to *Rubble Island*, 2¼ miles, and thence to the mouth of the river at *Point Marion*, 49¼ miles below Rowlesburg, there are no serious obstructions. The shoalest point between Beaver Hole and Point Marion is, however, found at Broad Ford, just above Rubble Island.

A large pocket boom has been constructed by Messrs. Huling & Co. about one-fourth mile above Point Marion, for storing the logs intended for their mill, which is located on the right bank of the Monongahela, about 2¼ miles below the mouth of the Cheat. From 175 to 200 logs per day are sawed into lumber at this mill.

Messrs. Dewing & Sons have also constructed a mill of about the same capacity one-fourth of a mile below Point Marion, but have not operated the same as yet, owing to the fact that they have been unable to get their logs down the Cheat River.

I am indebted to Messrs. Huling & Co., Barker Brothers, John A. Clark, Mr. Hostetter, and others for valuable information regarding the lumber interests on the river.

Summary.

Locality.	Distance from Rowlesburg.	Rock obstructions to be removed.
	Miles.	*Cubic yards.*
Calhoun Island	2¼	.....
Buck-Horn Ripple	3½	450
To one-half mile below Buck-Horn Ripple	.....	240
Hickory Bear Pen Run	4⅛	370
Between Hickory Bear Pen and Shanty Runs	.....	970
Shanty Run to	5¼	810
Bear Wallow Run, inclusive	6	
Between Bear Wallow Run and Oil-Mill Run	.....	1,470
Oil-Mill Run	7	1,000
Pringle Run to the	7⅛	620
Foot of the Narrows, inclusive	8	
Morris Island	10¼	.....
Mason Ripple	12¼	75
Muddy Creek	16¼	75
Small Falls	16¾	1,080
Between Small Falls and the Great Falls	.....	630
The Great Falls	18⅛	935
Green Island	20¼	270
Between Green Island and Barker Timber Chute	24¼	1,790
Between Barker Timber Chute and McMullen Timber Chute	27¼	600
Sackett's Harbor	27⅞	310
Between Sackett's Harbor and Sandy Creek	29¼	.....
Devil's Den	29⅞	205
Short Ripple	30¼	15
Bee Run Ripple	31⅛	60
Beaver Hole	33⅛	10
Laurel Island	34¼	.....
The Whirlpool	34¼	30
Grassy Island to a point 1½ miles below	36¼	130
Quarry Run Bar	38¼	15
Forge Island	39⅛	.....
Rood Island	40¼	.....
Point Marion	49¼	.....
Total	.....	12,270

The cost of removing these obstructions is estimated at $1 per cubic yard, $12,270.
Respectfully submitted.

CHAS. E. REES,
Assistant Engineer.

Lieut. Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

D D 13.

PRELIMINARY EXAMINATION OF MUSKINGUM RIVER FROM ZANESVILLE TO DRESDEN, OHIO.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 15, 1889.

GENERAL: I have the honor to submit the following report on the "Muskingum River, from Zanesville to Dresden," as ordered in the river and harbor act of August 11, 1888.

The Muskingum is the largest and most important of the rivers within the boundaries of the State of Ohio. It drains the larger portion of the eastern half of the State, its headwaters extending to within 25 miles of Lake Erie, where they interlock with those of the Cuyahoga. The river proper begins at Coshocton, where the Tuscarawas and Walhonding rivers unite, and it flows thence past the towns of Dresden,

Zanesville, McConnelsville, Beverly, and Lowell to its junction with the Ohio at Marietta, a total distance of 108 miles. Its chief tributaries are Wills Creek, Wakatomaka Creek, Symms Creek, Licking River, Moxahala Creek, Salt Creek, Meigs Creek, and Wolf Creek. The area of its basin is 7,780 square miles.

About fifty years ago the State of Ohio improved the navigation of the Muskingum by building eleven dams and twelve locks, thus forming a continuous navigation at all stages from the Ohio River at Marietta to the town of Dresden, where a junction was made with the Ohio Canal, which runs from Portsmouth, on the Ohio River, to Lake Erie at Cleveland. The standard size of the locks was 180 feet in length between hollow quoins and 36 feet in width; but unfortunately lock No. 12, at Symms Creek, the upper one of the series, was only 120 feet long and 22 feet wide, and was thus too small to pass the steamboats that navigated the river below Zanesville. Besides this defect in size, the lock was located so far above the head of Pool 10, that boats could not reach it in low water. The combination of these two causes made the lock of little use, and when the dam gave way the State failed to repair it, and practically abandoned the river above Zanesville.

Ever since the Muskingum River passed into the hands of the United States the residents along this part of the river have urged the restoration of slackwater to Dresden, but they wish a new lock, having the same capacity as the other locks on the river, and located at a point where it will always be accessible during low water.

After a careful survey and examination of the river below the old lock, I have selected a new site at Ellis, where the Cincinnati and Muskingum Valley Railroad crosses the river, and the accompanying map shows the locality and the lift of the proposed lock. The references in the river show the height of the bed above mean ocean level, and it is evident from the profile that the outlet of the new lock will have a depth of 5 feet in low water. The crest of the dam has been placed at such a height as to give 5¼ feet on the lower miter-sill of the lowest lock of the Ohio Canal at Dresden.

The probable amount of commerce to be developed by extending the existing slackwater to Dresden can not be predicted with accuracy, as the conditions of transportation have greatly changed since the upper lock and dam went out of use, but the annexed report of Lieut. Lansing H. Beach, Corps of Engineers, shows that there was a large business on this section of the river in 1860, the latest year for which statistics are now attainable. It is reasonable to suppose that the general development of commerce since that date will at least restore to the river the transportation of heavy freights that it had before; it is not improbable that the revised commerce will even exceed its former magnitude.

The estimated cost of a new lock and dam at the site selected is $139,000.

The locality is worthy of improvement. No further survey is necessary, as all the facts in the case have been determined.

Accompanying this report is that of Lieut. L. H. Beach, Corps of Engineers, and also a map of the proposed site of the new lock and dam.

Respectfully submitted.

W. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT LANSING H. BEACH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Zanesville, Ohio, January 9, 1889.

SIR: I have to submit the following report upon the preliminary examination of the Muskingum River from Zanesville to Dresden, directed by the river and harbor act of August 11, 1888:

This portion of the river, 14 miles in length, was the part of the Muskingum first provided with slackwater navigation. The dam at Symms' Creek was located some 2 miles above the point reached by the backwater of the Zanesville dam, afterwards built and now known as No. 10; the effect of this location was to interrupt navigation at low water, and as the lock was only 22 feet by 120 feet, while all locks below it were planned to be 36 feet by 180 feet, boats too small to be profitable upon the rest of the river had to be employed upon this portion, and even they were stopped in winter by ice and in summer by sand-bars. Under these unfavorable conditions, with tolls as high as on other parts of the river, traffic by steamers did not long survive the building of the Dresden extension of the Cincinnati and Muskingum Valley Railroad in 1871. The State of Ohio made no effort to place this portion of the Muskingum on an equality with the rest, and as the demands upon moneys appropriated were most urgent for other locks and dams having a larger business, the works at Symms' Creek were allowed to fall into the state of ruin in which they now are, the dam having almost entirely disappeared and the lock being unserviceable. A low bridge, unprovided with draw, built in 1878 by the city of Zanesville at Fifth street, without protest from the State, effectually closed the upper river to steam-boats, and all traffic since has been by means of flats poled by hand.

The Ohio Canal is connected with the Muskingum at Dresden by a canal about 3 miles long known as the Dresden Cut-off. The canal and cut-off, as well as the Muskingum below Zanesville, are in navigable condition, which makes the portion between Zanesville and Dresden the missing link of a water-way from Lake Erie to the Ohio River. The opening of the rich coal fields along the Muskingum has called attention to this water-way as a means of placing coal cheaply on the markets of the lake cities, and has created a strong desire to have the water-way complete. The lumber trade in the opposite direction is estimated to be of hardly less amount and value, and, in addition to these two great staples, the general traffic, it is believed, will be sufficient to more than repay the cost.

To effect the improvement in question would involve the building of a lock and dam about 9 miles above Zanesville at the locality shown by the accompanying map. The lock should be of the same size as the others on the river, so that a fleet of barges or coal boats could be taken the entire length of the river by one steamer. The most favorable site for the lock and dam is just below the Cincinnati and Muskingum Valley Railroad Bridge, crossing the river about 9 miles above Zanesville, a map of which locality accompanies this report.

The estimated cost of the improvement is as follows:

Lock	$85,000
Dam	36,000
Abutment	8,000
Levee behind abutment	8,500
Lock-keeper's house	1,500
Total	139,000

The commercial statistics of this part of the river are not easily procurable for the years immediately preceding the abandonment of its navigation; for in 1861 the Muskingum Improvement was leased to a company whose books are not accessible, and under their charge the works deteriorated to such an extent that during the latter part of the time covered by their lease and after its expiration navigation of this section of river was attended with so many difficulties and was so frequently interrupted that business was forced into other channels. The amount of local carrying done during the four years preceding the time when the lessees took the river is partly given below:

	1860.	1859.	1858.	1857.
Barrels merchandise.....number..	2,603	7,183	11,562	19,681
Ice.....pounds..	.....	1,102,500	.....	.....
Iron.....do....	487,754	551,470	48,154	316,320
Ore, iron.....do....	2,037,550	2,409,190	751,369	116,245
Lumber.....feet..	1,079,443	1,270,307	751,217	361,913
Marble.....pounds..	55,920	115,637	394,175	477,018
Miscellaneous.....do....	7,851,749	4,308,703	5,104,125	2,248,205

These figures represent merely the amount of business upon which the collector at Dresden levied tolls, and as through shipments or those whose toll was paid at Zanesville would not be reported by him, it is evident that the amounts above given can be fairly considered as representing less than half the actual commerce passing over this part of the river.

Owing to the development which has taken place of late years in the coal, clay, and sand interests of this section, it is believed that the business done over this part of the river would be many times what it was before, and of a magnitude sufficient to make the improvement a matter of great importance.

Very respectfully,

LANSING H. BEACH,
First Lieut. of Engineers.

Lieut. Col. W. E. MERRILL,
Corps of Engineers.

APPENDIX E E.

IMPROVEMENT OF THE FALLS OF THE OHIO AND OPERATING AND CARE OF THE LOUISVILLE AND PORTLAND CANAL—IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS, AND OF WHITE RIVER, INDIANA.

REPORT OF MAJOR AMOS STICKNEY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Falls of the Ohio, Louisville, Kentucky.
2. Indiana Chute, Falls of the Ohio River.
3. Operating and care of the Louisville and Portland Canal.
4. Wabash River, Indiana and Illinois.
5. White River, Indiana.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 9, 1889.

GENERAL: I have the honor to transmit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1889.

* * * * * * *

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

E E 1.

IMPROVEMENT OF THE FALLS OF THE OHIO RIVER AT LOUISVILLE, KENTUCKY.

This work is carried on under two divisions—the enlargement of the upper portion of the Louisville and Portland Canal and the enlarging of canal basin.

ENLARGEMENT OF THE UPPER PORTION OF LOUISVILLE AND PORTLAND CANAL.

This work was prosecuted during the year under three contracts, but the progress has been so slow that a change of method has been determined upon. The stage of the river has been unfavorable for the work,

and the inadequate preparation of the contractors for working at any but the lowest stages has resulted in the loss of almost the whole season, especially in the excavation.

The contracts of Gleason & Gosnell and of John Molloy for excavating having expired after two long extensions of time, further extension was refused, and authority obtained to purchase the necessary plant and finish the work by hired labor. A plant has been prepared and active operations will be commenced as soon as the river falls sufficiently. Provisions will be made for continuing operations at a considerably higher stage of the river, and it is hoped that a vigorous prosecution of the work will result in the completion of a large part, if not the whole, of that which was under contract. About 90,000 cubic yards of rock are to be removed. Arrangements have been made with Mr. J. B. Speed to haul the rock after it is loaded on cars. He has provided two locomotives, trestle over dumping-ground, and track to the dumping-ground, all of which will be ready by the time that active operations can commence.

The time for completion of contract for building the new canal wall was extended from December 31, 1887, to October 31, 1888, and to October 31, 1889, as it was deemed probable that the contractors would finish the work.

It is probable that work will be commenced during the year upon that portion of the canal wall not embraced in the existing contract, and also, if practicable, upon the excavation on the south side of the canal.

A modification of the project for the enlargement at the head of the canal has been submitted, and the subject referred to a Board of Engineer Officers in connection with the project for improving the Indiana Chute.

ENLARGING CANAL BASIN.

This work, under the contract of Gleason & Gosnell, has dragged along, but little progress being made. The extended time for completion having expired December 1, 1888, authority was obtained to purchase the necessary plant and finish the work by hired labor. The plant has been prepared, is now about all in place, and active operations will commence as soon as the river falls sufficiently to permit the pumping of the pit. It is believed that it will be finished this season.

The reports of Assistant Engineers G. W. Shaw and R. R. Jones upon different parts of the work are appended.

The commercial statistics will be found with the report upon the Louisville and Portland Canal, of which these improvements will form a part.

Money statement.

July 1, 1888, amount available		$18,447.05
Add amount covered by contracts July 1, 1888		140,048.41
Amount appropriated by act of August 11, 1888		150,000.00
		308,495.46
July 1, 1889, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1888	$38,235.66	
July 1, 1889, outstanding liabilities	17,606.65	
July 1, 1889, amount covered by existing contracts	11,194.42	
		67,036.73
July 1, 1889, balance available		241,458.73
Amount (estimated) required for completion of existing project		855,363.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. GRANVILLE W. SHAW, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 30, 1889.

MAJOR: I have the honor to submit the following report of operations on that portion of improving Falls of the Ohio River at Louisville, Ky., which is included in the enlargement of the Louisville and Portland Canal:

The present project is the enlargement of the Louisville and Portland Canal from a point about 400 feet below the railroad bridge to its head, which is being executed in accordance with the plans recommended by Lieut. Col. William E. Merrill, Corps of Engineers, in his annual report for 1883, with some modifications suggested in subsequent reports.

The work embraces the excavation and removal of earth, loose and solid rock; the removal of the old river wall, and the building of a new canal wall along the north line of the proposed enlargement from a point about opposite Tenth street west; the removal of the present canal wall and guiding-dike, and of that portion of the cross-dam south of the middle chute; the construction of a dam on the west and north limits of the enlargement above Tenth street, and the construction of a wall and stone slope revetment on the south side of the canal, from the upper guard-gates to the elevator basin, near the railroad bridge.

The work has heretofore been carried on under four contracts, as follows:

With George W. Lewis, for excavation and removal of old river wall on the lower section; with John Molloy, for excavation and removal of old river wall on the middle section; with Gleason & Gosnell, for solid rock excavation on the upper section, and with the Salem Stone and Lime Company, for constructing part of the new canal wall.

The contract with George W. Lewis was executed July 1, 1885, and the work completed November 24, 1886.

The contract with John Molloy was executed on the same date, the work to be completed by December 31, 1886.

Two supplemental contracts were subsequently made, extending the time for completing the work to December 31, 1887, and December 31, 1888, respectively. The work not having been completed at the expiration of the latter date, the officer in charge was authorized to purchase a plant and finish it by hired labor.

The contract with Gleason & Gosnell was executed August 4, 1885, with the provision that the work was to be completed by December 31, 1886. Two extensions of time for completion were subsequently made, the last one terminating December 31, 1888. The work not having been completed at the expiration of the latter date, the officer in charge was authorized to purchase a plant and to finish it by hired labor.

The contract with the Salem Stone and Lime Company for the construction of part of the new canal wall was executed January 15, 1887. The time for completing the work was first extended to October 31, 1888, and afterward to October 31, 1889. The work under this contract will probably be completed in August, 1889.

The work under these contracts during the fiscal year 1889 was as follows:

On the middle section, John Molloy contractor, work was begun June 26 and suspended July 13; resumed July 23 and suspended August 22; resumed October 1 and suspended October 22. The contract expired December 31, 1888.

On the upper section, Gleason & Gosnell contractors, work was begun June 26 and suspended July 11; resumed July 30 and suspended August 22. The contract expired December 31, 1888.

On the new canal wall, the Salem Stone and Lime Company contractors, work was begun August 1 and suspended October 24, 1888. During the high stage of the river the contractors were engaged in putting in dowels in the coping course, from October 24 to December 1, 1888. Work was resumed April 22 and discontinued on account of high water on June 7, 1889.

The following tables show the original estimates, the amount of work completed, and the amount done during the fiscal year ending June 30, 1889, under the above contracts:

Original approximate estimate of materials to be excavated and removed, and amount of masonry in new canal wall.

Materials.	Salem Stone and Lime Company.	Upper section (Gleason & Gosnell).	Middle section (John Molloy).	Lower section (George W. Lewis).
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Earth excavation	.....	.....	94,461	103,356
Solid-rock excavation	.....	110,000	46,449	37,402
Loose-rock excavation	.....	.....	1,500	500
Dry wall removed	.....	.....	4,152	5,413
New canal wall	9,000	.....	.....	.....

In preparing the foundation of the new canal wall it was found necessary on account of loose ledges to go deeper than was estimated, which will increase the quantity of masonry to about 10,300 cubic yards. A detail survey of the area covered by the late contract of Gleason & Gosnell increases the approximate quantity of rock excavation to 116,000 cubic yards.

The following quantities of excavation had been removed from the upper, middle, and lower sections, and of masonry laid in the new canal wall on June 30, 1889:

Materials.	Salem Stone and Lime Company.	Upper section (Gleason & Gosnell).	Middle section (John Molloy).	Lower section (George W. Lewis).
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Earth excavation	.....	.....	75, 584. 68	86, 649. 13
Solid-rock excavation	.....	35, 435. 22	38, 128. 23	33, 897. 16
Loose-rock excavation	.....	.....	4, 868. 65	8, 813. 21
Dry wall removed	.....	.....	11, 830. 89	9, 922. 50
Masonry, new canal wall	8, 926. 7	.....	.....	.....

The following shows the amount of materials excavated and removed, and the amount of masonry laid in the new canal wall during the fiscal year ending June 30, 1889:

Materials.	Upper section (Gleason & Gosnell).	Middle section (John Molloy).	New canal wall, (Salem Stone and Lime Company).
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
Earth excavation	.....	2, 499. 18	.....
Solid-rock excavation	.....	2, 491. 46	.....
Dry wall removed	.....	.....	.....
Masonry, new canal wall	.....	.....	2, 944. 66
Loose-rock excavation	.....	.....	.....

The high water in September, 1888, caused a break about 146 feet long in the guiding-dike on the north side of the canal east of the cross-dam. This break was repaired in October at a cost of $348.90 for material and labor.

In the latter part of October a survey was made, and cross-sections taken on the south slope of the canal between the old guard-lock near Tenth street and Byrne & Speed's basin, near Thirteenth street, for the purpose of estimating the cost of a wall and slope revetment between those points.

Under the authority to purchase plant and perform the balance of the work to be done on the enlargement of the upper end of the Louisville and Portland Canal by hired labor, there have been purchased 4 steel boilers and fixtures for operating steam-drills; 1 steel boiler, engine, centrifugal pump, and fixtures for pumping out excavated area; 13 steam-drills, 90 dump-cars and couplings, 2,000 cross-ties, and 24 tons of steel rails. An agreement has been made with J. B. Speed for the transportation of the excavated material after it is loaded in cars.

On May 17, 1889, a temporary crib and platform was begun, on which it is intended to place the pump, engine, and boiler. A small force of men was also employed in removing part of the apron on the north side of the guiding-dike, for the purpose of putting in a structure to prevent leakage from the canal. The crib for the pump, engine, and boiler is completed. The work north of the guiding-dike was suspended May 24 on account of a rise in the river.

Very respectfully, your obedient servant,

GRANVILLE W. SHAW,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER.

Louisville, Ky., June 30, 1889.

MAJOR: I have the honor to submit the following report of operations on improving falls of Ohio River at Louisville, Ky., enlarging canal basin at head of locks, for the fiscal year ending June 30, 1889:

This work is fully described in Appendix D D of the Annual Report of the Chief of Engineers for 1887, pages 1838, 1839, its object being to attain a clear width of 215

feet, extending from the new locks to the basin above, covering a distance of 800 feet of the canal, the present width of which is but 90 feet.

The contractors, Messrs. Gleason & Gosnell, under contract dated January 13, 1887, and extensions thereto, have, for the fiscal year ending June 30, 1889, excavated material as follows:

Excavation earth	cubic yards..	7,682

The total quantity of material excavated under the above contract up to the close of the fiscal year ending June 30, 1889, is as follows:

Excavation earth	cubic yards..	116,477
Excavation rock	do....	3,575

No material was excavated after October 22, 1888. The earth excavated was used to raise the grounds about the locks.

The extended time for the completion of this contract having expired December 1, 1888, it was determined to grant no further extension. The work of excavation will be continued, but directly by the United States Government by day's labor. The necessary plant has been procured, placed in position, and will be ready to operate whenever the stage of water in the river permits of the pumping out of the pit. Plant consists of 1 40 horse-power steam-boiler, 1 Blake steam-pump (10 inch discharge), 2 Rand steam-drills, 2 Duplex hoisting-engines (with boilers for operating the inclines), 12 dump-cars for removal of material from the pit. In connection with the above will be used about 3,800 feet of tracks, with the necessary frogs, switches, and turnouts.

The hoisting-engines are of the Lidgerwood pattern, duplex, with steam-cylinders 7 by 10 inches, mounted on cast-iron frame, with tubular boiler 3 feet 3 inches in diameter, shell 7 feet long, and containing 80 tubes 1¼ inches diameter and 4 feet 8 inches long, winding drums 16 inches diameter geared from driving-shaft. The engines are placed on a strongly framed oak trestle, high enough to allow the cars to pass directly underneath, as they are raised from, or lowered to, the pit over the tracks of the incline.

IMPROVING FALLS OF THE OHIO RIVER.

Repairs to flat-boats and small boats.—The covered barge used in connection with movable dam has had new roof placed on house and has been repainted.

Office boat.—A new hull was built and the office removed from old hull and placed thereon.

One flat-boat was placed in dry-dock and extensive repairs made. Owing to a rise in the river the dock was flooded June 3. Work was resumed June 14, but the dock was flooded the second time by a sudden rise in the river June 17, and work stopped. A few days would suffice to put this boat in condition to remove from the dock.

Small boats.—Three of the small boats have been thoroughly overhauled and repainted, and some work done on another.

Very respectfully, your obedient servant,

R. R. JONES,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

E E 2.

IMPROVEMENT OF THE INDIANA CHUTE, FALLS OF THE OHIO RIVER.

It has been impracticable to do any work on this improvement during the past year on account of the stage of the river. The location of the work is in the main channel on that part of the falls where the current is the swiftest, and it is only at a low stage that any work can be done.

A project for making this channel available at a lower stage has been submitted, and a Board of officers of the Corps of Engineers was assembled to consider it. The project, if successfully carried out, would permit of the passage of nearly, if not quite, all of the coal-fleets which now pass this point through the canal, and would relieve the Louisville and Portland Canal to such an extent that its capacity would suffice for all purposes for many years to come.

The Board had one meeting and then adjourned until certain information could be obtained concerning the flow of water at the 8-feet stage, which is the stage that governs many of the points in the construction of the proposed works.

As this stage does not occur with great frequency and usually lasts but a day or part of a day, there have been difficulties in obtaining the information desired. The river has been gauged to ascertain the discharge at this stage; observations have been made at the cross-dam to determine the division of the flow at that point; the changing elevation of the surface at all points under the railroad bridge measured; and numerous observations made to determine the very irregular surface slopes. Sufficient information has now been obtained to permit of another meeting of the board for a final discussion of the subject.

The importance of the proposed improvement may be estimated by the fact that 56,261,129 bushels of coal passed through the canal during the year just closed.

In September about 60 feet of the cross-dam, just north of the guiding dike, was carried away. Two attempts were made to close the gap, but were unsuccessful, on account of the rising of the river. The gap will be closed as soon as possible.

The report of Assistant Engineer G. W. Shaw and commercial statistics are appended.

Money statement.

July 1, 1888, amount available		$9,412.44
Amount appropriated by act of August 11, 1888		15,000.00
		24,412.44
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$455.74	
July 1, 1889, outstanding liabilities	10.50	
		466.24
July 1, 1889, balance available		23,946.20

Amount (estimated) required for completion of existing project	115,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. GRANVILLE W. SHAW, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 30, 1889.

MAJOR: I have the honor to submit the following report of operations on Falls of Ohio River, Indiana Chute, for the fiscal year ending June 30, 1889:

The present project has for its object the removal of projecting rocks and reefs in the Indiana Chute, between the cross-dam and railroad bridge, so as to secure an unobstructed channel 400 feet wide on that part of the falls.

Previous to 1887 the work was mainly directed to the removal of reefs and adjacent projecting points on the north side of the chute. During the very favorable season of 1887 the entire left-hand reef on the south side of the chute and a number of projecting points in the main channel were located and removed. The work remaining to be done consists in the removal of the solid ledges on either side of the channel within the limit of proposed improvement and in raising the guiding dike on the north side of the chute.

The high stage of river during the summer and fall of 1888 prevented any work being done on this improvement.

The effect of the work already done on the commerce of the river has been to produce a safe and straight channel 250 feet wide for the passage of vessels and tows, and to materially decrease the danger of navigating this part of the falls.

In December, 1888, the river was gauged at a point near the pumping-house of the Louisville Water Company, for the purpose of ascertaining the discharge at a stage of 8 feet on the upper canal gauge.

In October, 1888, an accumulation of heavy drift formed above the cross-dam, at the abutment on the south side of the middle chute and at a point about half way between the middle chute and guiding dike A force of men was employed to remove this drift, as its weight was endangering the dam.

In the latter part of September, 1888, it was found that about 60 feet of the cross-dam, just north of the canal, had been carried away. In October a crib around the opening was begun but work was discontinued on account of a rise in the river. On May 27, 1889, another attempt was made to close the gap, but a sudden rise in the river closed the work on May 30.

The falls and canal gauges have been read and recorded, and a new bench established near the pumping-house of the New Albany Water-works, with a view to placing a permanent gauge at that point.

The amount expended on this work during the fiscal year ending June 30, 1888, was $467.24.

Very respectfully, your obedient servant,

GRANVILLE W. SHAW,
Assistant Engineer.

Major AMOS STICKNEY,
Corps of Engineers, U. S. A.

Statement of vessels passed over the falls of the Ohio River during the fiscal year ending June 30, 1889.

DESCENDING VESSELS.

Month.	Passenger boats.		Tow-boats.		Square barges.		Model barges.		Total.		Days navigable.
1888.	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	
July	25	10,671	5	898	17	5,016	2	1,600	49	18,185	11
August	18	7,927	2	379	10	3,648	....	.....	30	11,954	11
September	32	15,548	1	107	6	732	....	.....	39	16,387	26
October	28	12,681	9	3,240	52	33,296	....	.....	89	49,217	16
November	69	37,982	7	956	24	4,604	....	.....	100	43,542	30
December	29	12,088	1	107	9	1,296	....	.....	39	13,491	19
1889.											
January	56	28,317	4	456	17	2,448	....	.....	77	31,221	31
February	43	21,450	20	4,752	70	39,378	9	7,200	142	72,781	21
March	57	29,117	6	692	41	13,392	....	.....	104	43,201	29
April	38	21,482	2	260	16	2,592	....	.....	58	24,334	25
May	24	12,115	....	.....	13	1,872	....	.....	37	13,987	16
June	47	19,149	14	2,780	58	22,852	..	.....	129	44,781	30
Total	466	228,527	71	14,628	345	131,126	11	8,800	893	383,081	266

ASCENDING VESSELS.

1888.											
July	.....	.....	5	898	.....	.....	....	.....	5	898	2
October	2	768	8	3,012	.....	.....	....	.....	10	3,780	2
November	7	3,021	7	763	2	600	....	.....	16	4,384	6
1889.											
January	5	3,076	2	221	.....	.....	....	.....	7	3,297	5
February	19	10,718	13	2,378	18	7,272	....	.....	50	20,363	9
June	3	1,696	7	1,605	4	1,824	....	.....	14	5,128	5
Total	36	19,277	42	8,877	24	9,696	....	.....	102	37,850	29

Statement of commerce passed over the falls of the Ohio River during the fiscal year ending June 30, 1889.

Articles.	Amount.	Articles.	Amount.
Coal ..... bushels..	$2,786,000	Tobacco ..... hogsheads..	9487
Corn and wheat ..... do....	3,840	Cotton ..... bales..	2,973
Salt ..... barrels..	8,599	Hay ..... tons..	231
Whisky ..... do....	3,818	Iron ore ..... do....	455
Oil ..... do....	5,958	Lumber ..... feet..	126,000
Molasses ..... do....	2,484	Miscellaneous ..... tons..	11,000
Flour ..... do....	2,454	Steel rails ..... do....	6 400
Sugar ..... do....	3,606	Passengers ..... number..	9,247

Comparative statement of commerce passed over the falls of the Ohio.

Fiscal years.	Open river.			
	Descending vessels.		Ascending vessels.	
	No.	*Tons.*	*No.*	*Tons.*
1880–'81	1,220	307,055	503	149,396
1881–'82	1,793	537,906	750	226,965
1882–'83	1,294	396,240	179	61,582
1883–'84	1,384	432,575	301	96,757
1884–'85	708	231,695	95	24,239
1885–'86	1,296	408,619	373	102,536
1886–'87	1,793	991,974	667	298,567
1887–'88	1,514	863,237	361	127,239
1888–'89	893	382,061	103	27,389

E E 3.

OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL.

The canal was open for the passage of commerce during the year, with the exception of forty-six days. It was closed forty-two days on account of high water, and four days on account of the sinking of a loaded coal-boat in the lower lock, which had to be dredged out. Two coal-boats were sunk by striking the canal walls. No other accidents or delays of consequence have occurred.

It having become desirable to change the organization of the force employed upon the canal, a plan for reorganization was submitted April 10, 1889. With some modifications the plan was approved by the Chief of Engineers and Secretary of War, and has been carried into effect.

The change abolished the positions of superintendent, assistant superintendent, clerk, and traffic manager. The operating of the canal for the passage of commerce is separated from all other work, and is under the supervision of a master lock manager and a deputy lock manager. Most of the clerical work is done in the office of the officer in charge, and all other work is placed under the supervision of an assistant engineer.

REVETMENT OF SLOPES AT THE LOCKS.

This work, under the contract with P. H. Sweeney, has progressed very slowly, and it was found necessary to extend the time to July 30, 1889. The slopes were prepared for the revetment by hired labor, and

of the 4,000 square yards of revetment contracted for 3,139 square yards have been laid, leaving 861 square yards yet to be laid.

It is desirable to carry the revetment around the point at the end of the river bank, lower entrance of the locks, as this bank was left in an unfinished and ragged condition, and exposed the lower engine-house to injury from drift during high water. The bank has been built out and should be revetted, both for protection and to give a proper finish.

EXCAVATION OF CHANNEL AT LOWER ENTRANCE OF CANAL AND DRESSING CANAL WALL.

A drilling-scow has been built for this work. It is fitted with a boiler, pump, and two 5-inch Ingersoll steam-drills, mounted on movable trucks, and all of the necessary appliances.

No work of excavation has as yet been done, as the water in the river and canal has been too high to work economically. It is expected that the work will commence during the coming month.

The amount to be excavated in the channel below the locks is 2,400 cubic yards. The original estimate of cost was $19,200. The drilling-scow has cost about $3,700, leaving $15,500 to be provided in the allotment for the coming year.

DREDGING.

During the year two dredges with steamboat tender have been more or less employed in removing the mud deposited in the canal and at the entrances. Eighty-two thousand cubic yards were removed, and there have been no detentions on this account.

DRY-DOCK.

The dry-dock is in good condition, and has been used for the repair of the vessels employed on the canal, and by outside parties, when not needed for Government work; twelve boats, besides Government vessels, having been repaired there, occupying the dock for sixty-two days.

Two of the bridges over the canal have been refloored.

The shops and other buildings, boats, and scows have received more or less repairs.

The middle gates of the new locks have needed considerable repair, and have shown such signs of decay that it is deemed necessary to build new ones this year. The guard-gates of both new and old locks continue to hold out, but it is considered necessary to make provision for their removal in case they should develop any dangerous weakness.

The old dredge has been extensively repaired, and it is now in very good condition, and will, it is believed, last for several years longer.

Nothing has been done with regard to building the new mud-scows, or in extending the city water-pipes to the locks, on account of the utter failure of the contractors who were engaged in enlarging the canal basin in finishing their work, and thus preventing the occupation of the ground.

This enlargement work will now be done by hired labor and it is hoped will be finished during the coming season.

The coal used upon the canal during the past year was furnished by Austin H. Dugan. The same party was the successful bidder in the

proposals that were opened June 3, 1889, and contract has been entered into with him to furnish the coal needed during the coming year.

The usual tables of dredge-work, expenditures, and commerce, and the report of Assistant Engineer R. R. Jones, are appended.

The estimate of cost of operating and care of the canal for the fiscal year ending June 30, 1890, is as follows:

Regular pay-roll	$33,340
Extra labor	5,000
General repairs	5,000
Miscellaneous, fuel, oil, etc	5,000
New guard-gates, new locks	8,000
New guard-gates, old locks	2 345
New middle gates, new locks	6,500
Completing revertment of slopes above lock walls	1,150
Revetting lower end of river bank, 550 square yards, at $1.50	825
Two new mud-scows	4,000
Work trimming canal wall and rock beneath	1,000
Excavation of channel, lower entrance	15,500
Extension of city water-pipes to locks	2,000
Contingencies	5,000
Total	94,660

Financial statement for operating and care of the Louisville and Portland Canal for the fiscal year ending June 30, 1889.

Receipts:	
Auction sale	$83.00
Dockage	800.39
Dredging	30.00
Rent	97.50
Total	1,010.89
Expenditures:	
Office and general administration	13,612.44
Canal and locks	24,856.82
Dredging	14,182.19
Total	52,651.45
Prepairing slopes and building revetment	8,379.48
Building drill-scow	3,705.15
Repair of old dredge	1,922.64
Aggregate	66,658.72

Statement showing cost of passing boats and freight through the Louisville and Portland Canal for the fiscal year ending June 30, 1889, under ordinary running expenses.

Per lockage	$8.12
Per boat	7.69
Per ton	.029

NOTE.—In comparing the above statement with cost per lockage, etc., for former years, it will be noted that the report made by the superintendent of the canal for the fiscal year ending June 30, 1888, did not include all the expenses.

Detailed statement of expenditures for operating and care of Louisville and Portland Canal for the fiscal year ending June 30, 1889.

Date.	Office and general administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.
1888.								
July	$985.00	$198.15	$169.19	$1,352.34	$1,260.00	$218.90	$1,843.32	$3,322.22
August	875.00	39.93	58.16	973.09	1,260.00	104.21	1,214.29	2,578.50
September	965.00	35.08	194.97	1,195.05	1,260.00	122.34	1,160.91	2,543.25
October	855.00	38.19	533.20	1,426.39	1,260.00	172.48	2,221.57	3,654.00
November	965.00	25.91	257.09	1,248.00	1,260.00	369.65	153.83	1,783.48
December	855.60	26.60	60.27	941.87	1,260.00	119.88	149.90	1,529.78
1889.								
January	965.00	41.75	150.67	1,157.42	1,260.00	206.23	19.41	1,485.64
February	855.00	18.21	98.08	971.29	1,260.00	93.00	315.05	1,668.05
March	970.00	3.51	137.74	1,111.25	1,260.00	156.46	140.48	1,556.94
April	1,075.00	41.61	135.29	1,251.90	1,215.00	163.11	175.96	1,554.07
May	858.33	86.46	60.51	1,005.30	1,218.33	210.88	162.65	1,591.86
June	747.00	88.72	142.82	978.54	1,157.50	276.11	155.42	1,589.03
Total	10,970.33	644.12	1,997.99	13,612.44	14,930.83	2,213.20	7,712.79	24,856.82

Date.	Dredging.				Grand Total.
	Labor.	Supplies.	Repairs.	Total.	
1888.					
July	$875.00	$224.61	$24.41	$1,124.02	$5,798.58
August	875.00	293.47	6.20	1,174.67	4,726.26
September	875.00	277.14	373.29	1,525.43	5,263.73
October	875.00	133.89	34.83	1,043.72	6,124.11
November	875.00	138.34	10.20	1,023.54	4,055.02
December	875.00	160.57	13.65	1,049.22	3,520.87
1889.					
January	875.00	274.50	64.55	1,214.05	3,857.11
February	875.00	275.00	32.11	1,182.11	3,821.45
March	875.00	319.78	82.37	1,277.15	3,945.84
April	875.00	207.47	13.50	1,095.97	3,901.94
May	873.67	461.19	14.24	1,349.10	3,946.26
June	872.33	221.42	29.46	1,123.21	3,690.78
Total	10,496.00	2,987.38	698.81	14,182.19	52,651.45
Preparing slopes and building revetment					8,379.48
Building drill-scow					3,705.15
Repair of old dredge					1,922.64
Aggregate					66,658.72

Abstract of proposals for coal received in response to the advertisement dated May 2, 1889, and opened June 3, 1889, by Maj. Amos Stickney, Corps of Engineers.

No.	Name of bidder.	Kind of coal.	Quantity (more or less).	Price.
*1	Austin H. Dugan	Best Pittsburgh ..... bushels..	11,800	$0.10
		Second pool, Pittsburgh ..... do....	900	.10
		Ohio River or Kanawha ..... do....	34,500	.08½
		Anthracite egg ..... tons..	8	7.25
		Anthracite nut ..... do...	8	7.25
		Total cost	.....	4,318.50

* Recommended for acceptance.

Abstract of proposals for furnishing and delivering forage at the Louisville and Portland Canal, received in response to the advertisement dated May 2, 1889, and opened June 3, 1889, by Maj. Amos Stickney, Corps of Engineers.

Articles.	Quantity (more or less).	1. Bid of B. B. Connor.	2. Bid of George Becker.*	3. Bid of Casler, Troxell & Co.
		Cents.	*Cents.*	*Cents.*
Hay, timothy.....pounds..	10,000	84	75	84
Oats, black.....bushels..	300	34	32	32
Straw, wheat.....pounds..	500	35	35	50
Bran, middlings.....do....	600	60	75	75
Total cost.....	.....	$191.35	$177.25	$187.00

*Recommended for acceptance.

ABSTRACT OF CONTRACT.

Name: Austin H. Dugan. *Date:* June 19, 1889. *Purpose and consideration:* That the said Austin H. Dugan shall furnish coal for use on the Louisville and Portland Canal, and in offices at Louisville, Ky., for the fiscal year ending June 30, 1890, as follows: 34,500 bushels, more or less, of Ohio River or Kanawha coal; 11,800 bushels, more or less, of the best Pittsburgh coal; 900 bushels, more or less, of second pool Pittsburgh coal; 8 tons, more or less, of anthracite egg coal; 8 tons, more or less, of anthracite nut coal. That the said Maj. Amos Stickney shall pay for the said coal, when delivered as required, at the following rates, viz: For the Ohio River or Kanawha coal, 8½ cents per bushel; for the best Pittsburgh and second pool Pittsburgh coal, 10 cents per bushel; for anthracite nut and egg coal, $7.25 per ton.

REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER.

LOUISVILLE, KY., *June* 30, 1889.

MAJOR: I have the honor to submit the following report of operations for the care of the Louisville and Portland Canal for the fiscal year ending June 30, 1889:

REVETMENT OF SLOPES ABOVE ROCK WALLS.

The preparatory work of removing superfluous earth and dressing the bank on both sides of the new locks was done directly by the United States Government by day's labor. On the south side 1,352 cubic yards of earth were removed; on the north side 1,361 cubic yards of earth were removed and used in making an embankment at the extreme west end of lock grounds, north side, for the protection of the lower engine-house, during a stage of high water in the river.

The revetment of the slopes has been done by Patrick H. Sweeney, contractor, under contract dated June 16, 1888, and extensions thereto.

The above contract calls for the delivery of stone and gravel backing, and the laying of the stone in place. During the fiscal year ending June 30, 1889, the contractor has delivered 958.7 cubic yards of stone, 1,213.9 cubic yards of gravel backing, and has laid 3,139 square yards of wall. Of this wall there has been laid on the south side 1,986 square yards, or about 730 lineal feet, and reaching an elevation reference 58 or 26 feet above lock walls.

On the north side, up to the close of the fiscal year, June 30, 1889, there have been laid 1,153 square yards of wall, or 460 lineal feet, and reaching elevation reference 58 feet.

Under the contract of Patrick H. Sweeney there were estimated to be laid about 4,000 square yards of wall, so that there yet remain to be laid under the above contract 861 square yards.

EXCAVATION OF CHANNEL, LOWER ENTRANCE, AND DRESSING CANAL WALL.

The above works are described in Appendix C C of the Annual Report of the Chief of Engineers for 1888, page 1729.

For the prosecution of the work there has been constructed a drilling-scow, 16 by 80 feet, fitted with spuds and capstans for moving into and holding position, and sup-

plied with one 40 horse-power steam-boiler, two 5-inch Ingersoll steam-drills mounted on carriages, which travel on tracks laid along the deck, and so arranged that the drills overhang clear of the boat; a duplex steam-pump for cleaning the holes after drilling, and all requisite steam and water-pipe, steam-hose, an injector, etc.

This drilling-scow is now ready to go into commission as soon as the stage of water in the river and canal will permit.

The drilling-scow is generally similar in design to the one built under your direction for use on the Des Moines Rapids of the Mississippi River, a complete description of which, with illustrations and detailed methods of work, is found in Part II, Report of the Chief of Engineers, 1880, page 1556.

DREDGING IN CANAL.

United States tow-boat and new iron dredge Louisville.—Small repairs only have been required from time to time on these boats during the fiscal year, and they are now in good condition; dredge *Louisville* painted throughout.

MUD-SCOWS.

Two of the mud-scows have been placed in the dry-dock and calked, and small repairs made from time to time on the other scows.

REPAIRS OF OLD DREDGE (NO. 1).

The old dredge was placed in the dry-dock October 8, 1888, but owing to high water was removed on the 19th of same month, and remained outside, dismantled, until December 3, 1888, when, the water permitting, it was again docked, repairs to the hull completed, and the boat removed from the dock January 12, 1889, repairs on upper works being continued after removal from dock.

Repairs consisted of new sides, corner-posts, spud-frames, turn-table, decking, dipper-handle, one new spud, small repairs to house, new canvas covering to roof, complete painting throughout, and general repairs to the machinery. Since these repairs have been made the dredge has done good work, and will be serviceable for some time to come, with such general small repairing only as is required on any boat of similar character.

The United States tow-boat and two dredges have been employed removing mud from the canal and approaches thereto.

I submit herewith tabulated statements of work done by them.

DRY-DOCK.

The dry-dock has been used by outside parties for the purpose of repairing steamboats, barges, etc. Twelve foreign boats have entered the dock and occupied it for a total period of sixty-two days.

BRIDGES.

A new upper floor was laid on the Eighteenth Street Bridge, July 23, 1888, and one on the bridge at new locks, August 2, 1888. The bell tower at lock bridge was rebuilt.

SHOPS AND OTHER BUILDINGS.

A shaving flue from planing mill to boiler-house was constructed and connected with exhaust fan. The shelter houses at middle and lower engine-houses, new locks, have been thoroughly repaired. The residence at the new locks has had small repairs, and a new kitchen shed was built. The wagon shed had extensive repairs made thereon; a new roof, one new side, floors, and partitions were made.

LOCK GATES AND MACHINERY.

The middle gates were repaired by re-enforcing arms and truss rods, and putting on new fenders. The upper, lower, and guard gates, had new fenders placed on them. New cylinder timbers were put under upper gate engines, south side. The steam pipe on south side of locks was covered with substantial boxing. Small repairs were made as required on lock gates and machinery.

GRADING LOCK GROUNDS.

A force of laborers has been employed grading the lock grounds, in accordance with plans submitted to the Chief of Engineers, November 1, 1888, and approved by him. A large amount of this work yet remains to be done.

Very respectfully, your obedient servant,

R. R. JONES,
Assistant Engineer.

Major AMOS STICKNEY,
Corps of Engineers, U. S. A.

Statement showing amount and cost of excavation by dredging during the fiscal year ending June 30, 1889.

Time at work	days	326
Cubic yards excavated	number	82,000
Cubic yards excavated per day	do	251
Cost:		
Wages for the year		$10,496.00
Repairs and supplies for the year		3,686.19
Total		14,182.19
Wages per day for year		28.76
Repairs and supplies per day		10.10
Cost per actual working day		43.50
Cost per cubic yard excavated		0.19

Detailed statement of dredging for the fiscal year ending June 30, 1889.

Month.	Dredge No. 1. Working days.	Scows.	Cubic yards.	Dredge Louisville. Working days.	Scows.	Cubic yards.
1888.						
July	21	109	4,360	21	147	5,880
August	10	52	2,080	25	167	6,680
September	14	81	3,240	15	88	3,520
October	.....	.....	.....	8	66	2,640
November	.....	.....	.....	7	58	2,320
December	.....	.....	.....	11	68	2,720
1889.						
January	6	28	1,120	12	70	2,800
February	18	98	3,920	17	131	5,240
March	10	68	2,720	13	155	6,200
April	20	124	4,960	19	128	5,120
May	23	111	4,440	22	112	4,480
June	18	100	4,000	16	89	3,560
Total	140	771	30,840	186	1,279	51,160
Total number of yards removed from canal	.....	.....	.....	.....	.....	82,000

Statement of vessels passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1889.

Date.	Passenger boats.		Tow-boats.		Coal boats.		Government boats.	
1888.	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
July	116	42,282	68	5,291	154	65,780	1	80
August	90	36,377	65	5,711	64	27,520	10	8,750
September	80	27,711	65	5,137	12	5,160	15	942
October	97	35,589	74	5,925	38	14,620	.....	.....
November	76	31,730	60	5,502	217	97,900	10	566
December	105	54,323	51	4,652	105	45,600	4	230
1889.								
January	75	30,474	47	4,032	128	55,440	12	901
February	59	24,341	33	2,454	82	36,660	.....	.....
March	97	37,787	73	6,557	337	135,466	1	86
April	119	47,791	102	10,499	254	102,140	29	1,786
May	104	38,252	72	10,933	97	39,849	.....	.....
June	58	25 114	57	6,365	19	7,714	10	635
Total	1,076	431,721	767	73,058	1,507	633,299	92	13,976

Statement of vessels passed through the Louisville and Portland Canal, etc.—Continued.

Date.	Square barges.		Model barges.		Small craft.		Total lockage.	
1888.	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*Tons.*	*No.*
July	214	66,395	21	6,168	20	694	185,946	658
August	140	23,170	8	2,398	23	400	103,926	486
September	148	29,005	13	3,353	30	363	71,308	490
October	178	35,168	18	5,848	26	431	97,100	520
November	252	64,436	17	5,934	31	663	206,068	441
December	224	50,636	15	4,306	6	510	159,747	565
1889.								
January	176	36,085	5	1,891	32	475	128,823	475
February	107	19,120	2	706	6	289	83,281	276
March	432	89,316	29	8,979	15	984	278,191	912
April	473	85,168	43	15,029	33	1,053	262,413	1,002
May	268	53,794	29	8,109	14	584	150,427	428
June	184	40,216	29	8,702	35	392	88,746	233
Total	2,896	592,509	229	71,423	271	6,838	1,815,986	6,496

Statement of commerce passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1889.

Date.	Coal.	Salt.	Oil.	Whiskey.	Tobacco.	Cotton.	Lumber.	Corn and wheat.	Iron ore.	Steel rails.
1888.	*Bush.*	*Bbls.*	*Bbls.*	*Bbls.*	*Hhds.*	*Bales.*	*Feet.*	*Bush.*	*Tons.*	*Tons.*
July	3,668,000	14,576	1,136	991	1,456	3,086	2,323,000	74,833	7,653	2,000
August	2,526,000	6,480	1,044	928	1,041	1,009	997,000	129,641	1,658	2,000
September	1,563,750	15,065	2,509	2,051	1,448	1,551	1,152,000	89,787	490	1,500
October	2,168,500	13,897	4,322	2,208	1,637	4,034	1,130,000	44,300	4,667	8,000
November	10,902,000	23,998	5,958	2,412	2,646	14,365	1,284,000	45,688	8,161	.....
December	5,635,000	13,973	3,913	760	2,581	8,809	742,000	25,327	6,346	10,000
1889.										
January	3,501,000	2,995	3,432	1,291	714	15,082	1,623,000	13,715	2,200	.....
February	2,445,000	5,264	4,082	1,609	1,818	12,090	1,836,000	6,383	861	12,000
March	14,566,000	24,095	10,338	2,973	8,999	13,392	2,709,000	179,886	33,246	.....
April	7,295,000	4,600	13,475	3,885	2,327	6,571	2,371,000	30,204	12,209	7,500
May	1,592,080	18,775	1,142	1,628	526	3,877	797,900	92,842	3,146	.....
June	378,799	5,696	1,240	672	1,152	545	323,600	9,786	3,118	5,800
Total	56,261,129	149,414	52,591	21,408	26,345	84,411	17,288,500	742,391	83,755	49,400

Date.	Produce.	Hay.	Flour.	Molasses.	Cement.	Cattle.	Sugar.	Staves.	Shingles.	Passengers.	Miscellaneous.
1888.	*Bbls.*	*Tons.*	*Bbls.*	*Bbls.*	*Bbls.*	*No.*	*Bbls.*	*No.*	*No.*	*No.*	*Tons.*
July	5,780	4,207	1,377	12,392	733	1,116	859	2,564,000	61,000	2,590	5,005
August	4,984	3,459	673	1,178	1,295	1,450	471	1,402,000	198,000	2,322	4,685
September	13,310	2,502	1,303	1,196	750	986	619	3,568,000	1,274,000	3,280	4,950
October	25,412	2,598	926	449	1,845	856	1,360	1,857,000	116,000	3,229	7,050
November	21,011	6,034	28,193	12,570	940	3,829	3,510	1,437,000	2,008,000	1,530	5,172
December	59,505	5,160	1,843	4,327	1,620	3,398	3,072	1,992,480	1,480,000	1,944	7,932
1889.											
January	3,362	2,908	618	3,591	2,975	1,286	979	1,190,000	137,000	1,152	5,434
February	1,568	3,583	2,171	4,134	1,000	971	2,116	1,300,000	1,500,000	1,282	5,606
March	7,598	6,839	4,260	2,879	750	4,458	4,217	7,509,000	7,056,000	2,095	8,226
April	4,850	3,501	2,356	2,315	3,450	3,097	1,695	4,400,000	9,800,000	2,200	9,059
May	909	150	1,020	613	1,075	1,367	664	1,812,400	159,500	2,152	8,618
June	844	200	400	75	546	522	473	1,464,840	184,000	1,847	7,678
Total	149,133	41,141	45,140	45,719	16,979	23,336	20,025	30,496,720	23,973,500	25,623	79,424

Commerce passed the Falls of the Ohio River by canal and by river.

Fiscal years.	Vessels through canal.		Open river.				Total.	
			Vessels descending.		Vessels ascending.			
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
1880-'81	4,196	1,124,838	1,220	377,055	503	140,306	5,919	1,642,199
1881-'82	3,964	904,343	1,793	537,906	750	220,965	6,507	1,663,214
1882-'83	4,954	1,226,455	1,294	398,240	179	61,802	6,427	1,686,497
1883-'84	4,346	1,070,650	1,284	432,575	301	98,757	6,031	1,601,982
1884-'85	4,886	1,217,231	708	231,695	95	24,320	5,689	1,473,246
1885-'86	5,057	1,254,342	1,296	403,619	373	102,536	6,726	1,765,497
1886-'87	4,768	1,157,250	1,793	991,974	667	290,507	7,228	2,439,731
1887-'88	5,471	1,315,851	1,514	863,237	361	137,230	7,346	2,316,318
1888-'89	6,638	1,815,986	893	383,081	102	37,850	7,633	2,236,917

Principal items of commerce passed over the Falls and through the canal during the fiscal year ending June 30, 1889.

Articles.	Amount.	Articles.	Amount.
Coal ..... bushels.	59,047,129	Cotton ..... bales.	87,389
Corn and wheat ..... do....	750,071	Lumber ..... feet.	17,414,560
Salt ..... barrels.	158,013	Staves ..... number	30,496,720
Whisky ..... do....	25,226	Live stock ..... do....	23,336
Produce ..... do....	142,133	Iron ore ..... tons.	84,243
Flour ..... do....	47,594	Steel rails ..... do....	55,800
Molasses ..... do....	48,203	Hay ..... do....	41,432
Cement ..... do....	16,979	Miscellaneous ..... do....	91,324
Sugar ..... do....	23,633	Shingles ..... number	23,973,500
Tobacco ..... hogsheads.	26,812	Passengers ..... do....	34,670

E E 4.

IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS.

IMPROVEMENT BELOW VINCENNES.

Work on this portion of the river included the procuring of material and building of lock at Grand Rapids, near Mount Carmel; protection of ground from erosion at the end of the levee near Grayville, Ill.; removal of snags between Mount Carmel and mouth of river, and the care of the plant.

LOCK AT GRAND RAPIDS.

In the beginning of the year this work was hampered by a second dilatory contractor, who finally failed to furnish the stone required, and it was necessary to make purchases in open market to get sufficient stone to warrant continuing the work of laying. Before all arrangements could be made and stone delivered the season of 1888 was well advanced. Work was commenced in wall laying July 7, but was so much interrupted by high water and lack of stone that but little was accomplished till the new supply commenced to arrive in October. Work was suspended for the season November 10, and but little has as yet been done this season, on account of high water.

The stone purchased in open market was from the quarry of the Salem Stone and Lime Company, at Salem, Ind., and not only proved satisfactory in every way, but was delivered as promptly as circumstances

would permit. At the opening of new proposals for stone, April 23, 1889, this company proved to be the lowest bidders, and contract was entered into with them to supply about $23,000 worth of stone, about one-half of which has been delivered.

It is expected now that there will be no more vexatious and costly delays, except such as are unavoidable from the lack of funds to complete the work. As soon as the stage of river will permit the laying of masonry will be resumed, and it is hoped it may be continued without interruption till the funds are exhausted.

GRAYVILLE BEND.

The levee at this point is in good condition, but it was found that the ground beyond the end of the levee was being cut away by the passage of flood-water through low places across the neck of land.

It is highly important to prevent this, and a low dam of loose stone was placed across the low places in continuation of line of the levee to stop the current until the back water raised sufficiently to reduce the slope of the surface of water passing overland to the river below. It is contemplated during the coming season to place sloping spur-dikes in the upper bend, to prevent the cutting away of the river bank at the narrow part of the neck upon which the levee stands.

SNAG-BOAT.

The snag-boat was put to work below Mount Carmel for such time as the limited amount of funds would permit, and accomplished good results.

WHITE RIVER SHOAL.

The rock shoal between Mount Carmel and the site of the lock is a barrier to low-water navigation, and has been the cause of considerable difficulty, delay, and expense in getting material to the lock. It was contemplated to commence operations in opening a channel through the shoal. As this is open river work, a low stage of water is necessary to prosecute it, and it was deemed best not to commence until the beginning of the low-water season, so as to have a probability of a comparatively long time for work with the water at a low stage.

ESTIMATES.

The following table of estimates is presented for important work in this part of the river:

Completing lock and dam at Grand Rapids	$90,000
Completing protection of bank at Grayville	6,000
Completing channel through White River Shoal	15,000
Work at Widow Goss and Skidmore Bars	20,000
Work at Little Chain	20,000
Work at Grand Chain	25,000
Dam at Little-Chain Cut-off	2,000
Dam at New Harmony	25,000
Removal of rock at Marshall's Ferry	1,000
Work at Coffee-Island Chute	3,600
Snagging one year	5,000
Repairs to work, maintenance of plant, contingencies	10,000
	221,600

The item for snagging should appear each year until the river is well cleared.

The report of Assistant Engineer O. L. Petitdidier is appended, also such commercial statistics as could be obtained.

Money statement.

July 1, 1888, amount available		$9,698.90
Add amount covered by contracts July 1, 1888		10,365.77
Amount appropriated by act of August 11, 1888		60,000.00
		80,064.67
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$35,084.63	
July 1, 1889, outstanding liabilities	4,746.47	
July 1, 1889, amount covered by existing contracts	11,219.41	
		51,050.51
July 1, 1889, balance available		29,014.16
Amount (estimated) required for completion of existing project		221,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for furnishing stone for lock, received in response to the advertisement dated March 22, 1889, and opened April 23, 1889, by Maj. Amos Stickney, Corps of Engineers.

[Delivered at railroad switch near the river at Mt. Carmel, Ill.]

No.	Name of bidder.	Special stones, 116 cu. yds.	Coping, 230 cu. yds.	Cut stone, dressed face, 545 cu. yds.	Cut stone, quarry face, 535 cu. yds.	Backing, 400 cu. yds.	Total cost.
		Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	
*1	†Salem Stone and Lime Company†	$15.60	$14.42	$13.00	{$12.50 ‡11.42	$11.00	{$23,298.70 ‡22,400.90
2	Edward Crumbo	24.00	22.00	18.00	16.00	14.00	31,814.00
3	I. V. Hoag, jr.	23.00	17.00	16.50	15.25	12.00	28,529.25

*Recommended for acceptance.
† A member of the firm is one of the sureties.
‡ If of uneven color.

All proposals received are more or less informal in unimportant particulars.

Amount available for payments under proposed contract $23,000, less contingent expenses.

ABSTRACT OF CONTRACT.

Name: Salem Stone and Lime Company. *Date:* May 10, 1889. *Purpose and consideration:* That the said Salem Stone and Lime Company shall furnish and deliver at the railroad switch, near the Wabash River, at Mount Carmel, Ill., such quantities of stone as may be directed or required by the said Maj. Amos Stickney, in accordance with the said advertisement and specifications. That the said Maj. Amos Stickney shall pay for the said stone, when delivered as required, at the following rates, viz: For special stones, $15.60 per cubic yard; for coping, $14.42 per cubic yard; for cut stone, dressed face, $13 per cubic yard; for cut stone, quarry face, $12.50 per cubic yard, or, if of uneven color, $11.42 per cubic yard; backing, $11, or, if of uneven color, $10.20 per cubic yard.

REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *July* 1, 1889.

MAJOR: I have the honor to submit the following report on improvement of the Wabash River, Indiana and Illinois, for the fiscal year ending June 30, 1889:

IMPROVEMENT BELOW VINCENNES.

The project of improvement adopted for the Wabash River aims at obtaining a depth of 3½ feet at low water, such a depth to be obtained by means best suited to the local features of each obstruction.

In pursuance of the project, cuts through long chains of rocks have been made, and dikes in sand-reaches, and dams across harmful cut-offs have been built; these improvements being for the most part successful.

At Grayville, where a cut-off was threatened, a levee has been constructed, while at Grand Rapids, where the most serious obstruction exists, a lock and dam are now in process of construction.

A snag-boat has also been employed in removing snags from the channel for several years, but this had to be abandoned on account of lack of appropriations until the last fiscal year.

During the last fiscal year the work done has consisted of continuation of masonry work at the lock at Grand Rapids, supplementing levee at Grayville by stone dike across erosions in the land, and removing some of the worst snags in the channel from Mount Carmel to the mouth of the river.

LOCK AND DAM AT GRAND RAPIDS, 92½ MILES ABOVE MOUTH.

The progress of this work, which was in state of construction at the beginning of the fiscal year, has not been so rapid as we were led to expect, owing to the inability of the contractor to furnish the stone as rapidly as it was needed, and, ultimately, to his failure to complete his contract. It being then too late in the season (September 12, 1888) to enter into a new contract for stone, as this would have entailed a delay of not less than forty days, it was decided to purchase stone in the open market, giving an order for $10,000 worth of stone to the Salem Stone and Lime Company, whose prices were, on the whole, lower than those of Charles E. Rees, our former contractor.

Stone entirely satisfactory was furnished by the Salem Stone and Lime Company, with all possible rapidity, but the majority of our order being composed of special stones, which had to be cut to templets, it was found impossible to keep the supply equal to the demand, and the season of 1888 closed without our being able to lay all the stone which had been engaged.

During the winter and early spring the delivery of stone purchased from the Salem Stone and Lime Company was completed, and the stone was piled on the bank to await transportation to the lock by steam-boat as soon as the stage of water should become favorable.

In answer to advertisement and specifications of March 22, 1889, for stone for the continuation of work on the lock, the Salem Stone and Lime Company put in a bid, which, being the lowest, was accepted, and a contract entered into on May 10. The prices bid differ only slightly from the estimate, so that no increase in cost of work is apprehended from this cause.

Since the award of the present contract the stone has been furnished by the contractor with promptness and there is every reason to believe that the stone will now be furnished as fast as wanted, as one-half of the stone contracted for has been furnished at this date.

The stone was piled up 8 feet high around two derricks awaiting for a rise in the river, but no rise occurring until the first week in June, it was found necessary to take some of the stone to the lock and resume laying of masonry in order that our derrick at Mount Carmel might be kept free to unload the cars as fast as they arrived. The stones were carried by team from the switch at Mount Carmel to the mouth of White River and thence by barge to the lock, the cost of transportation not exceeding by very much that of transporting by steam-boat and barges alone.

Stone laying was resumed May 20, 1889, and continued with vigor until interrupted two weeks later by a rise in the Wabash River, which has caused a suspension of work until this date. Advantage was taken of the rise to transport all the stone at Mount Carmel to the lock by the water route, this being nearly completed to-day.

There is now a large quantity of stone on hand, and it is intended to resume stone laying within this week, with the prospect of no further interruption until the available funds are exhausted.

The progress of completion of lock-walls is at this date as follows:

Lower miter-sill completed; upper miter-sill and lift wall one-half done; land-wall erected for its whole length, and to an average height of 12 feet; river-wall nearly completed for its whole length to an average height of 6 feet.

I append the following data on the work done during the fiscal year ending June 30, 1889:

Stone received from Charles E. Rees	cubic yards..	79.3
Stone received from Salem Stone and Lime Company	do....	1,511.6
Total stone received during the fiscal year	do....	1,590.9
Stone transported to the lock	number..	1,339
Masonry laid	cubic yards..	1,743
Masonry laid, reported in former report	do....	820
Total amount masonry laid to date	do....	2,563
Rock excavation for foundations	cubic yards..	250
Approximate cost of transportation of stone from Mount Carmel to the locks, partly by team and partly by barge, a distance of 2½ miles, per cubic yard.		$1.10
Mount Carmel to lock by steam-boat, including two handlings at the locks.		.92
Approximate cost of laying stone, including sand, cement, and all contingent expenses, per cubic yard		3.50

The price of laying is brought down in actual laying to about $2.25 per cubic yard, but experience has shown that when work can not be pushed with vigor to its completion there is a multitude of incidental expenses which can not be got rid of and the ultimate cost is thereby much increased.

It is proposed during the present fiscal year with the funds on hand to complete the river-wall to its full height of 27 feet, also to complete the upper miter-sill and lift-wall, and to carry the land-wall to a height of 14 feet or more if the funds on hand will allow, it being intended to leave the work in the best possible shape to resist the action of the elements until work shall be resumed.

As the navigation of the Wabash River will not receive any benefit from the construction of the lock and dam until such work is completed, it is very much to be hoped that sufficient appropriations will be made during next year to complete both lock and dam. This work could be completed within another year, provided appropriations are available early enough in the year to be able to enter into contract for stone, timber, and other materials needed for construction. The amount to be allotted specifically to the lock and dam should not be less than $90,000.

GRAYVILLE BEND CUT-OFF, 62 MILES FROM MOUTH.

The levee which was rebuilt in 1887 is still in good condition. This work has been very successful. Unfortunately the land upon which the levee stands is composed of a very light alluvial soil, which is very susceptible to fresh erosions whenever the land is overflowed.

The shape of the river is also such, at this place, as to throw a strong current at high water over the land adjacent to the ends of levee.

Serious erosions have already taken place on the east end of levee, and it is feared that the river will yet cut through in a very few years.

In order to check the action of current over the land adjacent to the levee, and prevent further enlarging of the erosions already made, a low stone dike, averaging 2 feet in height and 8 feet in width and 1,000 feet long, was constructed during the fall of 1888. This stone dike was built in continuation of eastern end of present levee, reaching across two depressions which had been caused by the action of high water.

The work done and expense have been as follows, viz:

Rock quarried	cubic yards..	568
Rock transported to site of work and placed by hand	do.....	419
Linear feet of stone dike completed		990
Total cost		$1,112.96

This work was, however, only as an adjunct to the main work contemplated of protecting the banks from erosion and in order to prevent, if possible, any irreparable erosion of the banks during the "freshets" of the coming winter.

The work intended to be done with the available funds during the coming fiscal

year consists of protection of river banks, adjacent to the levee, by means of 8 or 10 short spurs at right angles to the river bank, built of crib timbers, and suitably located so as to cause a deposit of silt and mud, and a refilling of the bank which has been washed away.

It is then hoped to gradually divert the main channel of the river to the north side of Bonpas Island, where it was many years ago.

Spurs, such as it is intended to construct, have been very successful in other rivers where they have been employed. The available funds on hand for this purpose are, however, too small to allow of any very complete work to be done, and should we have to record a failure of this attempt it will only be due to the smallness of means put in our hands, which are hardly adequate to the undertaking.

It is intended to begin work of construction of spurs within a few days.

SNAG-BOAT.

The snag-boat *Richard Ford* was sent out to remove some of the worst snags which had accumulated in the channel during the last few years, between Mount Carmel and the mouth of the river. The boat has done good work during the short time it has been possible to work with it, but the amount of work desirable to do is still very considerable, and unfortunately will have to be delayed until suitable appropriations for the lower part of the river are made. The sum of $5,000 yearly should be applied to snagging.

I append a few data in regard to work done by the boat during last fall:

Days in commission	number..	42
Snags removed	do...	151
Total weight of snags removed	tons..	901
Average length of each snag	feet..	53.6
Average weight of each snag	pounds..	11,939
Average cost of removing each snag		$7.65
Average cost per ton of snag		$1.283

CONDITION OF THE RIVER.

As there has been no work done on the lower portion of the river for a few years, several of our improvements have been either destroyed or rendered less efficient than before. This is particularly true at New Harmony, where the dam built on one side of Ribeyre's Island has been rendered useless by the river cutting around it.

AT LITTLE CHAIN.

The work of improvement having never been completed has that much sooner got out of repair, and is now of a doubtful benefit to navigation.

In addition to the several obstructions mentioned yearly in our reports, numerous snags also infest the lower river from the mouth to Grand Chain, and navigation at low water is both difficult and dangerous.

Although the amount of freight which could go by the water route is very great, steam-boat men have found it unprofitable to run their boats at low water, and during low water the boats are taken on the Ohio River.

As will be seen from the accompanying statistics, the amount of commerce reported as done on the Lower Wabash is small, the principal reason being the unusual length of time during which low water prevailed during last season, there having been in all hardly more than four months during which the river could be navigated.

The comparative statistics for the whole Wabash River also accompanying this report show an increase of trade on the whole river over the preceding year, this being due, however, to the influence of the Upper Wabash, where a good trade was done last season. I must add, however, that the commercial statistics of the Lower Wabash are incomplete, as it was found impossible to ascertain the amount of trade done by several steam-boats from the Ohio River which have made various trips during the winter months.

In conclusion I would add that I do not anticipate any increase in the commerce of the Wabash River until navigation is put on a permanent footing, such as to be independent of low-water stage.

The depth of 3½ feet contemplated in our present project, even if it could be obtained permanently, is too small to allow for the needs of present or future navigation, and if permanent improvement of the water-way must be obtained recourse will have to be had in the end to a system of slackwater navigation, such as is making many other rivers, which are much smaller and naturally less important than the Wabash River, channels of transportation of the first importance in the economy of the country.

The Wabash River, flowing as it does for many hundreds of miles through a constantly increasing extent of the most fertile land, is worthy of all improvement.

Very respectfully submitted. Your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

List of steam-boats plying on Wabash River below Vincennes during the fiscal year ending June 30, 1889.

Names.	Kind of boat.	Where plying.
City of Nashville	Stern wheel	New Harmony and mouth of river.
J. P. Drouillard	do	Do.
Nellie Hudson	do	Do.
Montezuma	Side wheel	Grand Rapids to mouth of river.
D. A. Gooden	Stern wheel	Do.
Jumbo	Floating saw-mill	Do.
A. Cary	Propeller	White River and mouth of river.
Louise	do	Mount Carmel and mouth of river.

Amount of freight carried by steam-boat and other craft on Wabash River below Vincennes for fiscal year ending June 30, 1889.

Articles.		Quantities.	Approximate value.
Lumber and logs "rafted"	feet, B. M.	18,500,000	$185,000
Spokes, fellies, and hickory butts	do	1,000,000	7,500
Corn	bushels	209,000	62,700
Wheat	do	20,000	15,000
Miscellaneous merchandise	pounds	120,000	12,000
Staves in bolts	number	400,000	4,000
Heading in bolts	do	600,000	4,800
Total			291,000

IMPROVEMENT ABOVE VINCENNES.

The amount appropriated by act of August 11, 1888 ($5,000), was not sufficient to attempt any work other than snagging, and was therefore applied to that work between Vincennes and Terre Haute.

In order that operations might commence as soon as possible for the relief of navigation, it was deemed advisable to charter a steamer to work at snag-pulling until there was sufficient water to permit the snagging outfit laid up at Mount Carmel to get up to Vincennes. There were so many snags at this portion of the river that navigation was suspended. A small stern-wheel steamer, the *Ida Lee*, was chartered, rigged with a derrick, and set to work on the 25th of September, and continued until December 1. The snagging outfit from Mount Carmel arrived November 15 and worked until December 29, when operations were stopped on account of the exhaustion of the funds. These boats did good service and opened navigation, but were unable to complete the work of clearing the river. At the close of the season the snagging outfit returned to Mount Carmel to be laid up.

It is evident that the work of removing snags must be done at intervals for an indefinite period, but this work would be comparatively

light for each year after a thorough clearing. In estimating an amount necessary to complete existing project it must be understood that additional obstructions coming into the river will require additional work. It is probable that $2,000 or $3,000 a year would keep the river clear of snags after it had been well cleared out.

ESTIMATES.

The following table of estimates is for the more important work needed in this part of the river, and any funds that might become available would be applied to the objects stated:

Snagging five months, at $800 per month	$4,000
Repairs to Eight-Mile Island Dam	500
Dredging	4,000
Contraction works and bank protection	10,000
Care of plant and contingencies	1,500
Total	20,000

The first item must appear yearly in estimates until the river is well cleared of snags.

The report of Assistant Engineer O. L. Petitdidier and commercial statistics are appended.

Money statement.

July 1, 1888, amount available		$60.03
Amount appropriated by act of August 11, 1888		5,000.00
		5,060.03
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$4,808.25	
July 1, 1889, outstanding liabilities	6.85	
		4,815.10
July 1, 1889, balance available		244.93
Amount (estimated) required for completion of existing project		20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MT. CARMEL, ILL., *June* 30, 1889.

MAJOR: I have the honor to submit the following report on the improvement of the Wabash River, above Vincennes, during the fiscal year ending June 30, 1889:

The project for the improvement of this portion of the river has consisted of removal of obstructions in the channel, construction of wing-dams, and closing of harmful channels.

An appropriation of $5,000 having been granted by Congress August 11, 1888, the work of improvement which had to be abandoned during 1887-'88 was resumed as soon as the funds became available.

As the amount appropriated was small no work could be undertaken beyond the removal of snags, which had become very numerous, and in places had completely blocked the channel at low water.

Wolf's Cut-off, of which mention has been made in previous reports, had become enlarged by caving of its banks to such an extent as to practically absorb the whole of the river, so that the channel through the old river had to be abandoned. The cut-off itself had, in the mean time, become so full of snags that it became impossible for the boats to pass the obstruction, even at a medium stage of water, and through navigation had to be suspended.

Other portions of the river between Wolf's Cut-off and Terre Haute had also become so full of snags that they were almost impassable.

Horse-Shoe Bend Cut-Off, 20 miles above Vincennes, had also become dangerous to navigation. In brief, navigation at low water was entirely suspended.

As the crops of 1888 along the lands bordering the river were very large, and the steam-boat men were very anxious to have the snags removed at the earliest opportunity, the steamer *Ida Lee* was chartered at once, and after being fitted as a snag-boat was put to work removing the worst snags in the channel below Terre Haute, until such time as our regular snag-boat could be brought up from Mt. Carmel, where it was detained below the Rapids by low water.

Work was begun by the *Ida Lee* on the 25th of September, 1888, this boat being joined by the *Osseo* and snag-scow on November 15, both boats remaining at work at the same time until December 1, when the *Ida Lee* was laid up.

The *Osseo* and snag-scow remained at work until December 29, when, the funds having been nearly exhausted, work was suspended.

The total amount of work done by the two boats and cost of same is as follows, viz:

Days at work	number..	99
Snags pulled, cut up, and disposed of	do.....	448
Weight of snags	tons..	1,906
Average length of snags	feet..	46.85
Average weight of snags	pounds..	8,545
Average cost of removing each snag		$7.92
Average cost per ton of snags		1.85

The work done by the boats has been of great benefit to navigation, but owing to insufficiency of appropriation could not be made as complete as desired.

I append the following letter from Mr. Allen Tindolph, of Vincennes, Ind., who operates the *Crown Point* and barges:

"VINCENNES, IND., *June* 26, 1889.

"DEAR SIR: The work done by your boat *Osseo* in clearing the drift and snags out of Wolf's Cut-Off and Horse-Shoe enable us to navigate these places with safety. Had they not been cleared of these obstructions it would have been impossible for our boats to run at any time this year, except this month of June, the water being higher this month than since 1886. We hope you may be able to come here and do more work this fall. The river needs it badly.

"ALLEN TINDOLPH.

"Mr. O. L. PETITDIDIER."

CONDITION OF THE RIVER.

The portion of the river between Terre Haute and Vincennes, 90 miles in length, has been much benefited by the removal of numerous snags during the last fiscal year, and is now in fair condition. It is not, however, to be ignored that such relief to navigation is only temporary, and that the yearly removal of snags for many years to come will be necessary in order to keep up with the wants of navigation.

The cut-off at Horse-Shoe Bend and Wolf's Cut-Off, which are now open, will probably be closed again, or at least become very dangerous to navigation, unless some work is done during the coming fiscal year.

Unfortunately, the failure of the appropriations during last session, and the exhaustion of the funds on hand, will prevent any work being done during the coming fiscal year, and it is feared that much of the good work done during the present fiscal year will go for naught.

There are, besides the snags, a few very bad gravel reefs, which could be easily dredged out, while some reefs of shifting sand could be cut out by light wing-dams. But these works, much as they are needed, can not be contemplated unless adequate appropriations are made at one time.

Our plant for the Upper Wabash consists of a snag-scow, fitted with suitable machinery, and the steamer *Osseo*, used as a tow-boat.

The *Osseo*, now some fourteen years old, is in such a poor condition that she is unfit to be used any longer, and it will be necessary, when contemplating snagging, to contemplate the building of a new snag-boat.

Although there have been but one hundred and forty-six days when the water was at such a stage that the boats could run, yet the amount of commerce on the river has increased to quite an extent, and that under the unfavorable condition of prolonged extreme low water and the formation and closing by snags of one cut-off.

The portion of country along the Wabash River is very fertile, and navigation, if brought to a permanent basis, would add greatly to the wealth of this section; but full success will be attained only by the use of slackwater navigation, which the probable commerce fully justifies, in my judgment.

Very respectfully, your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Showing the amount of freight carried by steam-boats and other craft on Wabash River above Vincennes during the fiscal year ending June, 30, 1889.

Articles.	Quantities.	Approximate value.
Corn ..... bushels..	432,159	$129,647.70
Wheat ..... do....	123,099	92,324.25
Oats ..... do....	46,000	11,960.00
Salt ..... barrels..	4,500	4,500.00
Lime ..... do....	2,500	1,500.00
Lumber ..... feet, B. M..	514,750	772,125.00
Flour ..... barrels..	1,450	4,350.00
Feed-meal ..... bags..	14,950	22,425.00
Hay ..... bales..	970	1,425.00
Miscellaneous merchandise ..... pounds..	1,543,700	154,370.09
Staves ..... number..	36,000	576.00
Passengers, average fare $1 ..... do....	1,116	1,116.00
Logs and lumber "rafted" ..... feet, B. M..	12,340,000	86,380.00
Total approximate value	.....	1,282,698.95

List of steam-boats plying on Wabash River above Vincennes during the fiscal year ending June 30, 1889.

Names.	Kind of boat.	Tonnage.	Where plying.
		Tons.	
Rosedale	Stern wheel.....	250	Vincennes to Terre Haute.
Ida Lee	....do	150	Do.
Cohasset	....do	99	Do.
Dauntless	....do	50	Terre Haute and points above.
Diana	....do	75	Do.
Little Joker	....do	50	Do.
Crown Point	....do	250	Vincennes and Terre Haute.

Comparative statement of commerce on Wabash River for the fiscal years 1886, 1887, 1888, *and* 1889.

Years.	Tons.	Approximate value.	Years.	Tons.	Approximate value.
1886	57,519	$1,190,868	1888	58,014	$585,006
1887	122,729	1,817,947	1889	106,513	1,573,698

E E 5.

IMPROVEMENT OF WHITE RIVER, INDIANA.

The work done during the year has consisted in the continuation of the improvement at Kelly's Ripple with the funds available at the beginning of the year, amounting to $2,592.23. In act of August 11, 1888, an additional amount of $5,000 was appropriated, with the proviso that it was not to be expended until the bridges over the river were so changed as not to obstruct navigation. Notice from the Secretary of War was served upon the railroad companies controlling the bridges to make such changes, and January 1, 1890, was the limit of time allowed for completion of changes.

As yet the bridges have not been changed, and consequently the amount of the last appropriation can not be expended. With the bal-

ance from old appropriation, however, work was done, which makes a good channel through the rock ledge 75 feet wide; and it is believed that this will serve for the present needs of navigation.

The dredge worked from the beginning of the fiscal year until September 30, when it was laid up. The amount of rock removed by the dredge was 7,835 cubic yards, which was placed in a dike along the side of the channel.

Some dike work will be needed to complete the improvement at Kelly's Ripple as far as it is deemed necessary to carry it for the present.

The report of Assistant Engineer O. L. Petitdidier and commercial statistics are appended.

Money statement.

July 1, 1888, amount available		$2,348.26
Amount appropriated by act of August 11, 1888		5,000.00
		7,348.26
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$2,120.74	
July 1, 1889, outstanding liabilities	3.75	
		2,124.49
July 1, 1889, balance available		5,223.77
Amount (estimated) required for completion of existing project		12,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *July* 2, 1889.

MAJOR: I have the honor to submit the following report on improvement of White River during the fiscal year 1888–'89:

The only work done during the fiscal year ending June 30, 1889, has consisted of the continuation of work at Kelly's Ripple, where the rock already blasted, but left in place, was being removed by the dredge.

As reported in former reports, the work of improvement at this place has consisted of cutting a chute through a chain of rocks known as Kelly's Ripple, this chute to be 2,250 feet long, 75 feet wide at the low-water mark, and not less than 3½ feet deep.

The dredge, which had already started on its last cut through the chute when last annual report was made, was kept steadily at work until the cut was completed, and the chute had a clear width of 75 feet between dikes at low water.

Dredging was completed on September 30, when the dredge was laid up, and a force employed in grading the material cast by the dredge to a uniform height of 5 feet above low water; this portion of the work was completed October 30, when all work was suspended and dredge put in winter quarters.

The work of improvement at Kelly's Ripple is now completed, the chute being cleanly dredged for its whole width of 75 feet, and having a minimum depth of 3 feet, so that boats and rafts pass readily through whenever stage of water is such that they can get to it.

I append a few data showing extent and cost of principal operations:

Rock removed by the dredge	cubic yards..	7,835
Days dredge was at work	number..	90
Average daily rate of excavation, including all the time dredge was in commission	cubic yards..	87.05
Lineal feet of dike graded to within 5 feet of low-water mark	feet..	2,035
Approximate total cost of dredging and grading		$2,405.80
Average cost of dredging and grading, including all expenses, per cubic yard		$0.30 7/10

The kind of rock dredged out has varied from rather soft soap-stone (coal measures) to hard sand-stone, and from débris of a few pounds in weight to blocks containing often 30 to 40 cubic feet.

CONDITION OF RIVER.

The condition of river is not very satisfactory, as, although at the place where work of improvement was done, we have obtained permanently a depth of 3 to 3½ feet where the former depth was counted by inches, yet there remain many portions of the river below Hazleton where a depth of less than 2 feet is found, the shoals being in most cases composed of sand-reefs.

Besides these obstructions, there are numerous snags which have lodged in the channel since snagging operations have been suspended.

Altogether the condition of the river at low water is poor, and navigation by steam-boats is almost entirely suspended, the principal obstruction to steam-boats being the Evansville and Terre Haute bridge at Decker Station, 2 miles above Hazleton.

This bridge is provided with a very imperfect draw, located over a sand-bar, to which boats can have access only at a stage 10 feet or more above low water.

There has been no step taken, so far as could be ascertained, by the railroad company to modify their bridge in accordance with request of Secretary of War, sent them last winter.

I append a table showing whatever commercial statistics it has been possible to obtain; also a comparative statement of commerce for the last four years.

I inclose a table giving names of the steam-boats which have made trips on the White River, with the exception that the *Hugh Barr*, a small steam-boat of 33 tons burden, is permanently at work above the Hazleton Bridge at Decker Station.

The last appropriation having been made conditional on the improvement of railroad bridge above mentioned, there are at present no available funds with which any work of improvement might be contemplated, but should there be any funds it would be recommended that the snag-boat *Richard Ford* be put in commission, removing numerous snags between Hazleton and the mouth of the river.

It is thought that three or four months' work, at an expense of $2,700 to $3,600, would be of great benefit to the navigation.

No new works are recommended, for the reason that it is felt that the present project of improvement to obtain a depth of 3 feet does not satisfy the needs or conditions of present or future successful navigation, and I am more convinced than ever that slack-water navigation is the only true method of improvement for rivers having such a régime as the White River.

The cost of improvement of a river by locks and dams is certainly expensive, but it is susceptible of a close approximation in the estimate, and, above all, the improvement is permanent.

Very respectfully submitted.

Your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

List of steam-boats plying on White River, Indiana, during the fiscal year ending June 30, 1889.

Names.	Kind of boat.	Tonnage.	Where plying.
		Tons.	
Hugh Barr	Stern wheel	33	Decker's to West Fork.
A. Carey	Propeller		Mouth of river to Hazelton.
Montezuma	Side wheel		Do.

Comparative statement of commerce on White River, Indiana, for the fiscal years 1886–'87, 1888, *and* 1889.

Years.	Tons.	Approximate value.	Years.	Tons.	Approximate value.
1886	*2,875	$28,000	1888	6,400	$71,145
1887	42,650	181,550	1889	27,000	137,950

* Incomplete.

Showing the amount of freight carried by steam-boats and other craft on White River, Indiana, fiscal year ending June 30, 1889.

Articles.	Quantities.	Approximate value.
Lumber and logs "rafted" ..... feet, B. M..	9,000,000	$105,000
Staves and heading ..... number..	4,000,000	32,000
Hay ..... tons..	50	250
Total approximate value	.....	*137,950

The steam-boat *Hugh Barr* has been at work on the West Fork during the past year, but no statistics could be obtained from her.

APPENDIX F F.

IMPROVEMENT OF GREAT KANAWHA, ELK, AND GAULEY RIVERS, WEST VIRGINIA, AND IMPROVEMENT OF NEW RIVER, IN VIRGINIA AND WEST VIRGINIA.

REPORT OF CAPTAIN THOMAS TURTLE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Great Kanawha River, West Virginia.
2. Operating and care of locks and dams on the Great Kanawha River, West Virginia.
3. Elk River, West Virginia.
4. Gauley River, West Virginia.
5. New River, Virginia and West Virginia.

(For letter of transmittal, see Appendix I.)

F F 1.

IMPROVEMENT OF GREAT KANAWHA RIVER, WEST VIRGINIA.

The object of the improvement has been to give a depth of not less than 6 feet all the year around throughout the whole river, 96 miles.

The means are locks and dams. The locks are about 300 by 50 feet.

The following table shows the present condition:

No.	Distance in miles from Charleston.	Style of dam.	Completed in—	Remarks.
2	26 miles above	Fixed	1887	In operation.
3	21 miles above	do	1882	Do.
4	15 miles above	Movable	1880	Do.
5	9 miles above	do	1880	Do.
6	4 miles below	do	1886	Do.
7	14 miles below	do		Under contract.
8	22¼ miles below	do		Now advertised.

One more site may be occupied above and several more below. Some dredging is also required in the pools, as well as the removal of snags and rocks.

The data for the preparation of the deeds for the site of Lock and Dam No. 8 were given from the office in Charleston last December, but owing

to what seems to have been most unnecessary delay in the preparation of these papers, the work on the lock has not yet been let at contract, and a most regrettable delay of practically an entire season in the completion of that work has resulted.

Mr. A. M. Scott has continued to exercise the local charge in his usual efficient manner. His report, which is appended, treats in detail of the operations of the year.

As the improvement of the river has progressed the commerce on it, notably the shipment of coal, has greatly increased.

The telephone line has been maintained between the central office in Charleston and the locks, and it is used by night as well as by day, being found indispensable for the proper oversight and direction of the operation as well of construction as of maintenance.

A gauge-reader has been kept at Kanawha Falls, near which place the Gauley joins the New to form the Great Kanawha River; and another at Hinton, where the Greenbrier empties into the New River. The compensation of these men is less than $10 a month each. They send to the central office daily reports by postal-card of the stage of the river at their respective stations, and by telegraph when there is a rapid rise. These reports are necessary as warnings to the central office in Charleston in order that such maneuvers of dams, etc., may be had in time as the height and duration of the freshets may require.

For perfect security a similar station should be occupied at some point on the Upper Gauley, and perhaps also on the Elk.

Money statement.

July 1, 1888, amount available		$5,895.62
Amount appropriated by act of August 11, 1888		350,000.00
		355,895.62
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	34,953.28	
July 1, 1889, outstanding liabilities	3,000,00	
July 1, 1889, amount covered by existing contracts	130,534,05	
		168,487.33
July 1, 1889, balance available		187,408.29
Amount (estimated) required for completion of existing project		970,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		500,00.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for building a lock-house and out-buildings at Lock No. 7, opened at the United States engineer office, Charleston, W. Va., at 4 p. m., September 12, 1888.

[Work in charge of Col. William P. Craighill, Corps of Engineers. Approximate quantities of excavation and masonry in foundations: Excavations, 65 cubic yards; masonry, 50 cubic yards; pier stones, 14 in number.]

No.	Name and address of bidder.	Lock-house, etc., complete, except excavations and foundation.	Excavation per cubic yard.	Masonry per cubic yard.	Pier stone, each.	Total amount of proposal.
1	Alexander H. Wilson, St. Albans, W. Va.	$2,465	$0.30	$5.00	$2.00	$2,762.50
2	Henry Crawford, St. Albans, W. Va.	2,600	.30	5.50	1.50	2,915.50
3	Martin V. Smith, Charleston, W. Va.	2,450	.27	5.25	2.00	2,758.05
4*	David Egan, Charleston, W. Va.	2,375	.27	4.00	1.00	2,696.55

*This proposal is not signed, but the bidder was present and acknowledged the proposal as his, as indicated by the guaranty.

Contract with David Egan.

Abstract of proposals for building guard-cribs at Lock No. 2, Great Kanawha River, opened at the United States engineer office, Charleston, W. Va., at 4 p. m., October 11, 1888.

	Approximate quantities.	No. 1. Layton Williams, Malden, W. Va.		No. 2. Keeney & White, Handley, W. Va.		No. 3. Charles F. Littlepage, Charleston, W. Va.		No. 4. John Morgan, Charleston, W. Va.	
		Bid.	Amount.	Bid.	Amount.	Bid.	Amount.	Bid.	Amount.
Timber and plank, per 1,000 feet, B. M..	80,000	$28.00	$2,240	$33.00	$2,640	$35.00	$2,800	$29.90	$2,392
Stone filling, per cubic yard.....	1,400	1.40	1,960	1.65	2,310	1.75	2,450	1.45	2,030
Drift-bolts and spikes, per pound.....	3,200	.04	128	.07	224	.07½	240	.02¾	88
Total.....	.....	.....	4,328	.....	5,174	.....	5,490	.....	4,510

Contract with Layton Williams.

Abstract of proposals for building Lock No. 7 of the Great Kanawha River improvement, opened at the United States engineer office, Charleston, Kanawha, W. Va., at 4 p. m., October 23, 1888, by Col. William P. Craighill, Corps of Engineers.

Materials.	Approximate quantities.	1. C. L. McDonald, Pittsburgh, Pa.		2. Branham & Hege, Indianapolis, Ind.		3. Carkin, Stickney & Cram, East Saginaw, Mich.		4. William A. McCosh, Parkersburgh, W. Va.	
		Bid.	Amt.	Bid.	Amt.	Bid.	Amt.	Bid.	Amt.
Grubbing and clearing, complete.	.....	.....	$100.00	.....	$1,000	.....	$2,000	.....	$400
Crib logs in coffer-dams, per lin. ft.	48,000	$0.20	9,600.00	$0.36	17,280	$0.28	13,440	$0.25	12,000
Sheathing, per 1,000 feet, B. M ..	27,000	20.00	810.00	40.00	1,080	30.00	810	30.00	810
Coffer-dam filling.....per cu. yd..	7,200	.50	3,600.00	1.00	7,200	.60	4,320	.75	5,400
Excavation .....do....	24,000	.95	22,800.00	1.25	30,000	.55	13,200	1.00	24,000
Excavation rock.....do....	500	3.00	1,500.00	5.00	2,500	4.80	2,400	2.00	1,000
Embankment.....do....	8,000	.45	3,600.00	1.00	8,000	.50	4,000	.50	4,000
Puddling .....do....	400	.75	300.00	1.25	500	1.50	600	1.00	400
Concrete.....do....	600	7.50	4,500.00	8.00	4,800	5.00	3,000	7.00	4,200
Backing masonry.....do....	5,800	7.25	42,630.00	10.00	58,000	4.40	25,520	8.50	49,300
Rock-face masonry .....do....	1,900	8.90	16,910.00	14.00	26,600	8.60	16,340	12.00	22,800
Pointed-face masonry.....do....	1,600	12.40	18,600.00	15.00	22,500	9.00	13,500	13.00	19,500
Cut-stone masonry.....do....	260	15.76	4,095.60	20.00	5,200	12.00	3,120	15.00	3,900
Sills .....do....	220	18.65	4,103.00	20.00	4,400	18.00	3,960	16.00	3,520
Quoins.....do....	75	23.65	1,773.75	27.00	2,025	25.00	1,875	20.00	1,500
Coping .....do....	340	17.65	6,001.00	27.00	9,180	25.00	8,500	16.00	5,440
Stone filling .....do....	3,200	1.50	4,800.00	4.00	12,800	1.50	4,800	1.90	6,080
Riprap, hand placed.....do....	2,200	2.50	5,500.00	4.00	8,800	3.00	6,600	2.25	4,950
Paving .....do....	950	6.50	6,175.00	5.00	4,750	5.00	4,750	2.50	2,375
Timber in permanent construction, per 1,000 feet, B. M.....	69,000	37.00	2,553.00	50.00	3,450	40.00	2,760	50.00	3,450
Bolt holes in masonry, per lin. ft..	1,200	.40	480.00	.35	420	.50	600	.50	600

Abstract of proposals for building Lock No. 7 of the Great Kanawha River improvement, etc.—Continued.

Materials.	Approximate quantities.	5. Hoag & Pelitdidier, Cincinnati, Ohio.		6. Higgs, Calderwood & Littlepage, Charleston, W. Va.		7. C. H. Strong & Son, Cleveland, Ohio.		8. Frank Hefright, Huntingdon, Pa.		9. Raffner & Grady, Charleston, W. Va.	
		Bid.	Amt.	Bid.	Amt.	Bid.	Amt.	Bid.	Amt.	Bid.	Amt.
Grubbing and clearing, complete	.....	.....	$1,000	.....	$1,000	.....	$2,000.00	.....	$1,500.00	.....	$25
Crib logs in coffer-dams, per linear feet	48,000	$0.20	9,600	$0.20	9,600	$0.24	11,520.00	$0.25	12,000.00	$0.20	9,600
Sheathing, per 1,000 ft., B.M.	27,000	30.00	810	22.00	594	40.00	1,080.00	50.00	1,350.00	30.00	810
Coffer-dam filling..per cu. yd.	7,200	.70	5,040	.75	5,400	.75	5,400.00	1.00	7,200.00	.35	2,520
Excavation.....do..	24,000	.70	16,800	.55	13,200	.75	18,000.00	1.00	24,000.00	.75	18,000
Excavation rock.....do..	500	1.70	850	1.40	700	2.00	1,000.00	2.50	1,250.00	1.75	875
Embankment.....do..	8,000	.45	3,600	.40	3,200	.40	3,200.00	.25	2,000.00	.40	3,200
Puddling.....do..	400	1.30	520	1.55	620	1.50	600.00	1.00	400.00	1.00	400
Concrete.....do..	600	7.00	4,200	6.50	3,900	9.45	5,670.00	8.50	5,100.00	6.50	3,900
Backing masonry.....do..	5,800	7.70	44,660	7.00	40,600	9.45	54,810.00	8.50	49,300.00	7.50	43,500
Rock-face masonry.....do..	1,900	11.00	20,900	9.50	18,050	9.45	17,955.00	8.50	16,150.00	10.00	19,000
Pointed-face masonry...do..	1,600	12.00	18,600	12.40	18,600	9.45	14,175.00	8.50	12,750.00	11.00	16,500
Cut-stone masonry.....do..	260	14.50	3,770	16.00	4,160	9.45	2,457.00	8.50	2,210.00	15.00	3,900
Sills.....do..	220	23.00	5,060	15.00	3,300	9.45	2,079.00	8.50	1,870.00	15.00	3,000
Quoins.....do..	75	21.00	1,575	20.00	1,500	9.45	708.75	8.50	637.50	20.00	1,500
Coping.....do..	340	19.00	6,460	19.00	6,460	9.45	3,213.00	8.50	2,890.00	23.00	7,820
Stone filling.....do..	3,200	1.50	4,800	1.85	5,920	1.50	4,800.00	3.00	9,600.00	2.25	7,200
Riprap, hand placed....do..	2,200	2.50	5,500	2.00	4,400	2.50	5,500.00	3.00	6,600.00	3.00	6,600
Paving.....do..	950	4.50	4,275	4.10	3,895	4.00	3,800.00	3.00	2,850.00	4.00	3,800
Timber in permanent construction, per 1,000 ft. B.M.	69,000	32.00	2,208	35.00	2,415	35.00	2,415.00	50.00	3,450.00	43.00	2,976
Bolt holes in masonry, per linear foot	1,200	.40	480	.15	180	.25	300.00	.25	300.00	.25	300

Contract with Carkin, Stickney & Cram.

SUMMARY BY TOTALS.

Contractor.	Amount.	Contractor.	Amount.
No. 1. C. I. McDonald, Pittsburgh, Pa.	$160,430.75	No. 6. Higgs, Calderwood & Littlepage, Charleston, W. Va.	$147,694.00
No. 2. Branham & Hege, Indianapolis, Ind.	230,485.00	No. 7. C. H. Strong & Son, Cleveland, Ohio	160,682.75
No. 3. Carkin, Stickney & Cram, East Saginaw, Mich.	136,095.00	No. 8. Frank Hefright, Huntingdon, Pa.	162,407.50
No. 4. William A. McCosh, Parkersburgh, W. Va.	175,625.00	No. 9. Raffner & Grady, Charleston, W. Va.	155,717.00
No. 5. Hoag & Pelitdidier, Cincinnati, Ohio	160,102.00		

Abstract of proposals for building a dump-boat for the Great Kanawha River improvement, opened at the United States engineer office, Charleston, W. Va., at 4 p. m., February 28, 1889.

No.	Name and address of bidder.	Amount.
1	J. E. Thayer, Charleston, Kanawha County, W. Va.	$1,450.00
2	Layton Williams, Malden, Kanawha County, W. Va.	1,405.50

Contract with Layton Williams.

REPORT OF MR. A. M. SCOTT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston, W. Va., June 10, 1889.

CAPTAIN: I have the honor to submit the following report on the Great Kanawha River improvement for the first eleven months of the fiscal year ending June 30, 1889.

LOCK NO. 2 (STATIONARY DAM).—OPERATING.

[Located 84¼ miles from mouth of river and 26¼ miles above Charleston.]

This lock has been in good order and regular operation during the year. Locking was suspended three times (forty-three hours altogether) by high water. The following is from the records kept at No. 2:

Through the lock during the eleven months:

Coal	bushels..	724,000
Coal barges		132
Steam-boats		1,271
Other craft		37
Passengers		4,355
Miscellaneous freight, merchandise, produce, etc.	tons..	2,105
Lumber and logs	feet, B. M..	367,200
Total number of lockages made		1,313

LOCK AND DAM NO. 2.—NEW WORK.

Riprapping banks.—Owing to want of funds in the winter of 1887-'88, when the lock was put in operation, the shore protection about the works was considerably curtailed. The banks, particularly on the abutment side where the soil is sandy, beginning to scour badly, it was found necessary to extend the riprapping both above and below the works. This has been carried on from time to time during the year, as circumstances required, with small forces of hired labor looked after, and as far as practicable, assisted by the regular lock hands.

About 1,520 cubic yards of stone have been placed on the abutment bank during the year, extending the protection 280 feet farther down and 165 feet farther upstream from the dam than before. In addition 518 cubic yards of riprap stone were piled up on top of the bank above the abutment for contingent use.

On the lock side, below the works, the bank was clear and graded for a distance of 285 feet farther down stream and 660 cubic yards of riprapping placed thereon.

All of this stone was taken from the Dunn and Connelton Coal Company quarries near the site; that for the abutment side being boated across the river.

Cribs at head of Lock 2.—Colonel Craighill contracted with Mr. Layten Williams, the lowest bidder, for building these cribs by agreement dated October 26, 1888. The contract was completed in December. The work consisted in extending the outer guard approaches up-stream 300 feet from the 48-foot crib first built at the head of the river wall by building three more cribs. They were made of square white-oak, drift-bolted and filled with stone, tops paved with large blocks. The upper crib is 20 feet by 40 feet on bottom, with sloping "ice-breaker" and; the other two are 20 feet by 30 feet on bottom. They are 27 feet high, tops 12 feet above pool level. The cribs are placed 50 feet apart in clear and on line slanting back, the upper one being 30 feet back from line of chamber wall. In building them 70,837 feet, B. M., of timber, 1,358 cubic yards of stone, and 3,230 pounds of drift-bolts were used. These cribs overcome the danger of boats being drawn over the dam in high stages, and together with the improvement made in the shore-line during the year (to be reported under the head of dredging), made the upper approach to the lock both safe and roomy.

Completing lock-house at No. 2.—This work was completed by the contractor, Mr. David Eagan, in August.

LOCK NO. 3 (STATIONARY DAM).—OPERATING.

[Located 79¼ miles from mouth of river and 21¼ miles above Charleston.]

Locking was suspended from October 5 to November 11 for the repair or change of the filling-valves, also on three days during the year by high water. With these exceptions the lock has been in regular operation.

The following is summarized from the lock records:

Through the lock during the eleven months—		
Coal	bushels..	1,410,000
Coal barges		355
Steam-boats		1,447
Other craft		55
Passengers		6,705
Miscellaneous freight, merchandise, produce, etc	tons..	2,913
Lumber and logs	feet, B. M..	775,800
Shingles		145,200
Total number of lockages made		1,551

Change in filling-valves.—The materials for this work (see Colonel Craighill's last annual report, in Report of Chief of Engineers for 1888, vol. 3, page 1753), consisting of the new valves, valve frames, maneuvering apparatus, timber for head-bay, coffer-dams, etc., were procured during the summer and early fall. The lock chamber was coffer-dammed so that the pumps were started October 8, but unusual high water after this delayed the work so much that the placing of the new valves was finally abandoned for the season. The chamber was pumped out in November, however, before the coffers were removed and the old valves overhauled and tightened. They were considerably improved and have been working better since. It is the intention to rebuild the coffer-dams and put in the new work during the low water this fall.

THE MOVABLE DAMS.

The three completed Chanoine dams, with the locks, have been in regular working order and operation. As usual a great deal has been done, mostly by the regular lock hands, in keeping the apparatus, buildings, and grounds in repair and order, but no extensive repairs have been necessary. A brief account of operations at each of the movable dams is given below.

It will be noticed that the dams were kept down during the year much more than usual. This was due to the remarkable high stages of water, before referred to, prevailing last autumn.

LOCK AND DAM NO. 4.—OPERATING.

[Located 73 miles from mouth of river and 15 miles above Charleston.]

The dam has been up ten days since July 1, 1888. It was put up and lowered four times. The dates of time taken in making the maneuvers, etc., is given in the following table:

Maneuver.	Date.	Time taken.	Men employed.	Remarks.
		h. m.		
Raised	July 2	7 30	5	In lowering September 5, the pier tripping-bar broke at the 14th wicket. Since then the shortened bar, tripping 13 wickets, has been in operation, the remaining 15 wickets on that side being tripped "by hand," i. e., with hook or lever. On the lock section 26 wickets are lowered with the tripping-bar and 8 with an improved shunting hurter. The latter were placed last fall for trial.
Lowered	Sept. 5	2 00	6	
Raised	Sept. 28, 29	15 00	4 to 5	
Lowered	Oct. 21	2 30	6	
Raised	Dec. 4, 5	16 00	5	
Lowered	Dec. 18	2 00	6	
Raised	May 11, 12	22 30	5 to 6	
Lowered	May 26	2 15	5	

The following is from the records kept at No. 4 for the the eleven months ending June 1:

Through the lock:		
Coal	bushels..	1,403,000
Coal-barges		376
Steamers		679
Other craft		12
Lumber and logs	feet, B. M..	136,000
Total lockages made		691

Through Navigation Pass:		
Coal	bushels..	4,988,000
Coal-barges		1,076
Steamers		1,718
Other craft		21
Lumber and logs	feet, B. M..	536,400

LOCK AND DAM NO. 5.—OPERATING.

[Located 67¼ miles from mouth of river and 9¼ miles above Charleston.]

The dam was standing one hundred and three days during the eleven months ending June 1. It was put up four times and lowered four times as below:

Maneuver.	Date.	Time taken.	Men employed.	Remarks.
		h. m.		
Raised	July 2, 3	10 15	4 to 5	No difficulty.
Lowered	Sept. 5	2 20	6	do.
Raised	Sept. 25, 26, 28	18 5	4 to 5	Delayed by water being too high.
Lowered	Oct. 12	2 10	5 to 6	No trouble.
Raised	Dec. 4, 5, 6	19 25	4 to 5	Five hours taken to put pier bar on track; also delayed by drift.
Lowered	Dec. 18	2 25	5	No difficulty.
Raised	May 11, 12, 13	20 20	5	Delayed by breaking trestle chains and by tripper being off track.
Lowered	May 26	2 30	5	No difficulty.

The following is from the records kept at No. 5 for the eleven months:

Through the lock:		Through Navigation Pass:	
Coal, bushels	3,457,000	Coal, bushels	10,308,500
Coal-barges	792	Coal-barges	2,108
Steamers	880	Steamers	2,151
Other craft	24	Other craft	33
Passengers	6,348	Lumber and logs, feet, B. M.	888,060
Lumber and logs, feet, B. M.	616,570		
Shingles	119,750		
Total lockages made	987		

LOCK AND DAM NO. 6.—OPERATING.

[Located 54 miles from mouth of river and 4 miles below Charleston.]

The dam was standing one hundred and four days during the time. It was put up and lowered six times, as follows:

Maneuver.	Date.	Time taken.	Men employed.	Remarks.
		h. m.		
Raised	July 2, 3	9 50	4	No difficulty.
Lowered	July 11	3 20	4 to 6	Four trestles held up by a large tree; all put down uninjured next day.
Raised	July 16	8 55	4 to 5	No difficulty.
Lowered	Sept. 5	2 45	4 to 5	Do.
Raised	Sept. 28	9 00	4 to 5	Do.
Lowered	Oct. 12	2 40	3 to 4	Do.
Raised	Dec. 4, 5	9 25	4 to 5	Do.
Lowered	Sept. 18	2 45	4	Do.
Raised	April 24, 25	8 25	4 to 5	Do.
Lowered	April 26	2 20	4 to 5	Do.
Raised	May 11, 12	9 00	4	Do.
Lowered	May 26	2 40	4 to 5	Do.

NOTE.—It will be noticed that this dam is let down oftener than the others. This is done to facilitate coal shipment from the Charleston, or No. 6, pool; the practice, on this account, being to lower No. 6 as soon as there is 6 feet for navigation in the open river below. Dams 4 and 5 are generally held up until the river gets, or is likely to get, up to about 7 feet open stage. Dam No. 6 can, if desired, be held up longer than the others, it having the most weir way.

The following is summarized from the records of Lock No. 6 for the eleven months ending June 1:

	Through the lock.	Through the Navigation Pass.	Totals.
Coal.....bushels..	1,514,000	22,946,500	24,460,500
Coal-barges	691	3,531	4,222
Steam-boats	473	2,026	2,499
Other craft	43	71	113
Passengers	2,782	6,875	9,657
Miscellaneous freight, merchandise, produce, etc ...tons..	4,814	23,532	28,346
Railroad ties	12,525	65,250	77,775
Saw-logs	1,470	3,350	4,820
Staves	.....	141,000	141,000
Tan barks.....cords..	.....	950	950
Sawed lumber.....feet, B. M..	150,000	808,000	958,000
Total lockages made	642	.....	642

LOCK NO. 7.—CONSTRUCTION.

[Located 44 miles from mouth of river, 14 miles below Charleston, and 1½ miles below St. Albans.]

Contract for lock.—In accordance with Colonel Craighill's advertisement dated September 11, 1888, proposals for building Lock No. 7 were opened October 23. The contract was let to the lowest bidder, Carkin, Stickney & Cram, of East Saginaw, Mich., by agreement approved December 7. Work was commenced in January by starting to open a quarry on Gregory's farm, on the opposite side of the river and about a mile from the lock-site. Work in the quarry, including cutting, was suspended from April 20 to May 20 by the failure of the contractors to supply money to carry it on, but with this exception fair progress has been made at preparing stone. There is now about 1,450 cubic yards out, 700 of which is face stone, rock, and pointed face, cut, the remainder being prepared backing.

Dredging for the coffer-dam was begun April 16, and the placing of the coffer commenced May 8. Some time was lost, too, in April and May on this part of work by lack of equipment and material to carry it on, but latterly, except as interrupted by high water, better progress has been made. One hundred and ninety-six lineal feet of coffer-dam (it will be 830 feet long altogether) are now placed, which includes the upper shore and two cribs on the long side.

The coffer-dam is made of round timber cribs 21 feet by 16 feet in plan, from 21 to 22 feet high, filled with coarse river bed (dredged) material, sheathed outside and banked with puddle clay topped with dredged material.

The lock will be of masonry, resting on solid rock. The bed-rock is found here from 11 to 12 feet below low-water mark. The lock, not including guard-cribs, will be 141 feet long; between hollow quoins, 343½ feet. Width of chamber, 55 feet. The walls are to be 20 feet high, above miter sills (5 feet above upper pool level) and about 25 feet high above bed-rock. The present contract includes the masonry, earth-work, guard-cribs, shore protection. In other words, the entire lock complete, except the gates.

Lock-house at No. 7.—A lock-house was built at this site during the year. It was built under contract with Mr. David Eagan, agreement approved September 29, 1888. The work was completed in March. It embraced a single lock-house (intended finally for lock-keeper) of eight rooms, including an office and store-room and the required outbuildings.

LOCK NO. 8.—SITE FOR, ETC.

[Located 35½ miles from mouth of river, 22½ miles below Charleston, and 21½ below Raymond City.]

Some additional surveys and borings for rock were made and the site definitely located last autumn. Agreements for the purchase of the necessary land at the site were also concluded early in December, but owing to delay in the Department of Justice in procuring title, proposals for building the lock have not yet been called for.

Drawings and specifications for the lock, and also for a single lock-house and office to be built at the site, have been made during the year.

DREDGING.

The dredge, assisted by the tow-boat *Bee*, was employed a considerable part of the working season last summer and fall at and near Lock No. 2, deepening and straightening the immediate approaches to the lock and the channel at Harvey's Shoal just below. The upper approach was widened and much improved by straightening the shore-line for about 500 feet above the lock; some blasting and crane-boat work was found necessary in connection with this.

The lower approach was deepened considerably and some work done at the head of Harvey's Shoal, but there is still a good deal of dredging to do below the lock, including Harvey's, to make 7 feet depth at lowest stages.

Nearly three weeks were occupied in August in removing deposit from the approaches and chambers of Locks 3 and 5. Two weeks' dredging was done at the head of Witcher's Creek Shoal in October. From October 16 to November 14 the dredge and tow-boat or the crews were engaged, when not stopped by high water, on the coffer-dams and repairs at Lock No. 3.

The river keeping too high to dredge, the boats were laid up November 16.

Repairs on tow-boat and dredge.—Considerable repairs were necessary on the tow-boat, her hull, deck timbers, guards, etc., having become badly decayed or worn. She was put on the docks and overhauled and repaired in April. The dredge was also docked and repaired before going to work this spring.

Work at Scary, etc.—Dredging was begun at Scary Shoal May 17, and has been under way there, except a few days' interruption by high water, since that date. The old dug chute is being widened and the dredged wall on the right made higher. The tow-boat men have complained a good deal about this place, and the work is being done at their request. There is a considerable dredging of about the same kind needed at Johnston Shoal just below Scary.

New dump-boat.—A contract for building another dump-boat for use with the dredge was made with Layton Williams, the lowest bidder, by agreement with Colonel Craighill, dated March 14. The boat is now nearly completed. It will be a four-binned side-dumper, 58 feet long and 20 feet wide at deck, with a capacity of 60 cubic yards.

TELEPHONE LINE.

In addition to ordinary repairs to the line, that part of it below Locks Nos. 5 and 6 has been moved from the right to the left bank of the river during the year, and the line extended from Lock No. 6 to No. 7. The line is now 50½ miles long, with eight stations, viz: Kanawha Falls, Locks Nos. 2, 3, 4, 5, 6, and 7, and Charleston office. The keeping of the telephone line and apparatus in order (as the operation of the movable dams particularly required) involves a considerable work and trouble. The repairs to the line are mostly made by the regular hands at the locks.

OFFICE AND FIELD WORK, ETC.

The principal items of work done under this head during the year are as follows: Drawings and specifications for Lock No. 8, and for the single lock-house and office proposed at that site; drawings and specifications for No. 7 lock-house, specifications for dump-boat, drawings and specifications for guard-cribs at Lock No. 2, drawings for new filling valves, etc., for Lock No. 3; detailed working drawings for Lock No. 7, additional surveys, soundings, and borings to rock at sites for Locks 7 and 8.

Mr. Thomas E. Jeffries, assistant engineer, has been employed regularly, and Mr. Theodore Schoonmaker, assistant engineer, the greater part of the year on general office, field, and inspection duty. Mr. William M. Peyton has continued to attend to the clerical work in this office, and to look after the property connected with the improvement. The faithful and valuable assistance of all these gentlemen is gladly acknowledged.

Very respectfully, your obedient servant,

ADDISON M. SCOTT,
Resident Engineer.

Capt. THOMAS TURTLE,
Captain of Engineers, U. S. A.

COMMERCIAL STATISTICS.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, West Virginia, June 30, 1889.

Statement showing the number of bushels of coal shipped from the Great Kanawha Valley, below Kanawha Falls, for the several years named.

Twelve months ending—	Shipments by river.	Shipments by railroad.	Total shipment.	Number of mines in operation.
June 30, 1881	9,628,696	6,631,660	16,260,356	13
June 1, 1883	15,370,458	13,290,255	28,660,713	26
June 1, 1884	18,421,084	12,059,172	30,480,256	28
June 1, 1885	17,812,023	12,972,217	30,784,540	23
June 1, 1886	17,861,613	13,953,745	31,815,358	26
June 1, 1887	23,283,374	19,160,896	42,394,270	27
June 1, 1888	20,100,625	20,962,686	41,063,331	36
June 1, 1889	26,921,788	22,031,121	48,952,909	35

The statement for the last year was, as usual, made up from detailed reports to this office from all the mines. It will be noticed that the output for the last year was considerably (nearly 16 per cent.) greater than ever before; the increase by river alone over the former maximum (1887) being over three and a half million bushels.

Respectfully submitted.

ADDISON M. SCOTT.

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

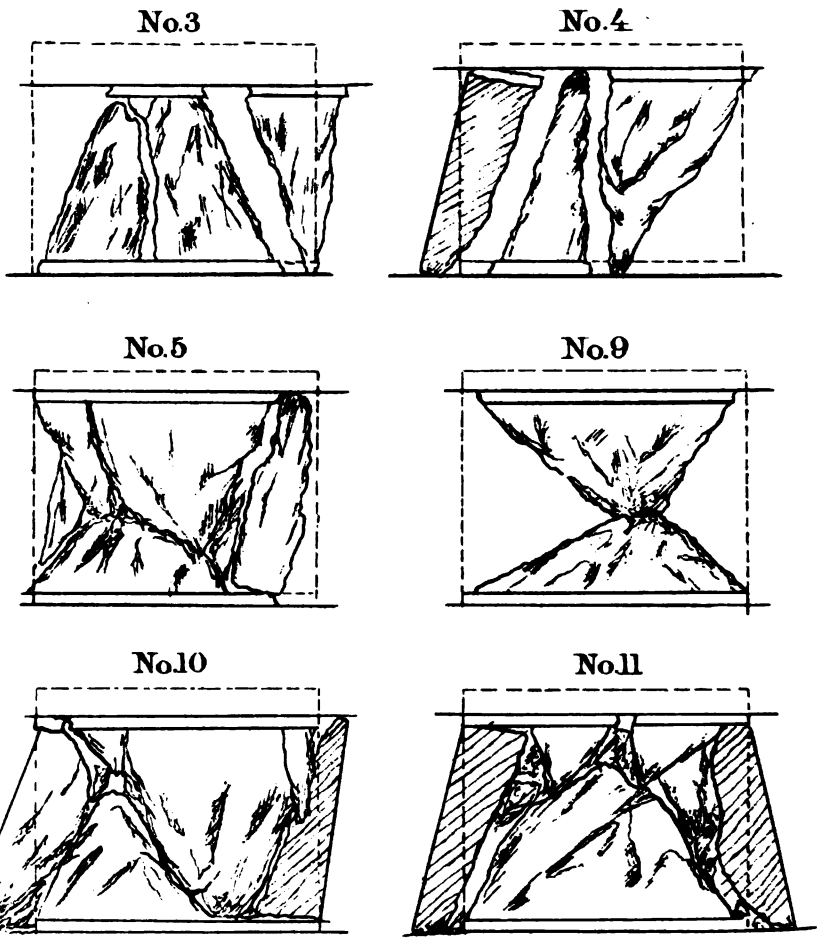
Tests of Great Kanawha sandstone made under direction of Lieut. Col. W. R. King, Corps of Engineers, for Capt. Thomas Turtle, Corps of Engineers, at Willets Point, N. Y. Harbor, May, 1889.

No.	Designation.	Strength of specimen.	Strength per sq. inch.	Position when crushed.	Remarks.
1	Gregory Quarry, south	25,000	6,250	On bed	Began to crack at 24,000 lbs.
2	Do	39,000	9,750	do	
3	Do	38,000	9,500	do	
4	Gregory Quarry, north	33,500	8,375	do	Bed not marked — assumed from appearance of stone.
5	Do	46,000	11,500	do	Do.
6	Do	33,000	8,250	do	Began to crack at 28,000 lbs.
7	Gregory Quarry, lower, inside	29,000	7,250	do	
8	Do	28,000	7,000	do	Began to crack at 22,000 lbs.
9	Gregory Quarry, lower, outside	30,000	7,500	do	
10	Do	24,000	6,000	do	
11	Gregory Quarry, lower, inside	27,000	6,750	do	Do.
12	Do	27,500	6,875	do	

The above is merely a preliminary record, giving the actual reading of the gauges, not reduced for variations in size of specimens.

The specific gravity, weight per cubic foot, and ratio of absorption have not yet been determined.

DIAGRAMS OF CRUSHED CUBES OF SANDSTONE.



REPORT ON THE COMPRESSIVE STRENGTH, SPECIFIC GRAVITY, AND RATIO OF ABSORPTION OF GREAT KANAWHA SANDSTONES, GREGORY QUARRY; MADE UNDER THE DIRECTION OF LIEUTENANT COLONEL W. R. KING, CORPS OF ENGINEERS, BY LIEUTENANT THOMAS H. REES, CORPS OF ENGINEERS.

The hydraulic press formerly used by General Gillmore in testing building stones was used in these tests. The same methods are here followed also, so that these results are comparable with those given in Appendix II, Annual Report of the Chief of Engineers, 1875.

The working of the press and gauges was roughly tested as follows:

	Pounds, mean.
To raise, support, and lower unloaded ram	600
To raise, support, and lower one 500-pound anchor	1,040
To raise, support, and lower two 500-pound anchors	1,555

The discrepancy in these readings is considerably within the smallest reading of the gauge.

Two gauges were used, one reading to 25,000 pounds and the other to 100,000. They read closely together up to the limit of the smaller. The latter was cut off when the pressure exceeded 25,000 pounds.

Crushing strength of Great Kanawha sandstones in two-inch cubes.

[Position when crushed, on bed.]

No.	Kind.	Locality.	Cracked.	Strength of specimen.	Strength per square inch.	Specific gravity.	Weight of one cubic foot.	Percentage of absorption.	Temperature when crushed.
									° F.
1	Drab, fine, compact	Gregory quarry, south	24,000	25,380	6,345	2,455	153.5	.028	62
2	do	do		39,230	9,808	2,471	154.4	.030	82
3	Drab, fine, friable	do		38,480	9,620	2,436	152.2	.036	62
*4	Drab, fine, compact	Gregory quarry, north		33,840	8,460	2,486	155.4	.027	62
*5	Gray, fine, compact	do		46,000	11,500	2,485	155.3	.027	83
6	Drab, fine, friable	do	28,000	33,500	8,375	2,490	155.6	.027	81.5
7	Gray, rather friable	Gregory quarry, lower inside		29,000	7,500	2,304	144.03	.047	77
8	do	do	22,000	28,380	7,095	2,291	143.2	.048	79.5
9	Gray, coarse, friable	Gregory quarry, lower outside		30,370	7,592	2,148	133.8	.056	61.5
10	do	do		24,350	6,088	2,279	142.4	.052	80
11	do	Gregory quarry, lower inside	22,000	27,510	6,880	2,342	146.4	.047	81
12	do	do		27,850	6,962	2,325	145.3	.047	62

* Bed not marked, assumed from appearance of stone.

The specimens were approximately 2-inch cubes; most of them were a little scant, however, and allowance has been made for this in the column "strength of specimen."

Weights for determining specific gravities were taken to the nearest millogramme, the fragments used weighing from 22,000 to 70,000 millogrammes. When weighed in water the pieces were hung by a few fibers of unspun silk, whose weight was almost inappreciable.

The appended diagrams show some of the more characteristic forms into which the specimens broke, as they appeared before being taken from the press.

Respectfully forwarded to Capt. Thomas Turtle, U. S. Engineers.

W. R. KING,
Lieut. Col. of Engineers.

REPORT OF TESTS MADE FOR COLONEL CRAIGHILL, CORPS OF ENGINEERS, BY GENERAL GILLMORE, IN MARCH, 1881.

Table showing crushing strength, specific gravity, etc., of eight 2-inch cubes of Kanawha stone.

Name and number of specimen.	Position when crushed.	Strength of specimen.	Strength per square inch.	Specific gravity.	Weight per cubic foot.	Ratio of absorption.
Preston quarry:		*Pounds.*	*Pounds.*		*Pounds.*	
No. 1	On bed	44,000	11,000	2,460	153.7	1-29
No. 2	do	48,000	12,000	2,458	153.7	1-30
No. 3	On edge	40,000	10,000	2,426	151.6	1-26
No. 4	do	42,000	10,500	2,403	150.2	1-25
Elk quarry:						
No. 1	On bed	41,000	10,250	2,444	152.7	1-30
No. 2	do	35,000	8,750	2,394	149.6	1-25
No. 3	On edge	44,000	11,000	2,438	152.5	1-30
No. 4	do	46,000	11,500	2,409	150.6	1-26

REPORT OF MR. A. M. SCOTT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston, W. Va., April 11, 1881.

CAPTAIN: The following considerations concerning the crushing strength of stone for Lock No. 6 are respectfully submitted. The results of the recent tests by General Gillmore, of the eight specimens from the Elk and Preston quarries, falling so much below our requirements, and the fact that these conditions are likely to prohibit the use of the most available quarries, has led me to make some comparisons of the Kanawha stone with other sandstones, by means of the reports, etc., at hand. It appears from the report of General Gillmore, to which you called my attention sometime ago (published in the Report of the Chief of Engineers for 1875, Vol. 2, page 819), as well as from other data consulted, that our requirements are practically much above the strength of nearly all, if not all, of the strongest sandstones in the country. In the "general table" of General Gillmore's report (beginning on page 846) he gives the strength of 56 2-inch cubes of sandstone from various places in the Northern States, 4 from New Brunswick, and 2 from Scotland. (These blocks were crushed between wooden cushions, and for comparison with the Kanawha stones that were crushed between steel plates, the red figures being the averages after increasing by 10 per cent. all over 40,000 pounds, as per table on page 845 of report, are given.)

From the report of trials on these sixty-two cubes I find the following:

Of forty-two on bed:	Pounds.	Of twenty on edge:	Pounds.
Average of all	32,340	Average of all	31,000
Highest	70,900	Highest	59,250
Lowest	17,000	Lowest	16,100

It appears that the strength of stone is generally proportional to the weight. Nearly all of these sandstones are lighter than ours. Twenty-six of them, however, run 140 pounds and over to the cubic foot. They show the following:

Fourteen on bed:	Pounds.	Twelve on edge:	Pounds.
Average	40,746	Average	37,574
Lowest	20,200	Lowest	22,200

If from these twenty-six heavy stones the three from Medina, N. Y., are eliminated, we have:

Twelve on bed:	Pounds.	Eleven on edge:	Pounds.
Average	35,900	Average	35,603
Highest	54,000	Highest	46,700

To compare these results with those obtained from trials of forty out of forty-five 2-inch cubes of Kanawha stone sent to General Gillmore by Captain Turtle, in January, 1880. All crushed between steel plates:

Twenty-six on bed:	Pounds.
Average	60,730
Highest	85,000
Lowest	46,500

Eleven broke under 60,000 pounds; nine broke at or under 55,000 pounds.

14 on edge:

	Pounds
Average	55,606
Highest	68,000
Lowest	35,000

The cubes not considered above are the four from top of mountain (No. 9 of table) not used in work, and the one on edge (No. 5 of table) reported at 80,000.

The comparison shows:

(*a*) That, leaving out the Medina stone, the *average* of the Kanawha on bed is above the strongest in the report.

(*b*) That the lowest of the Kanawha on bed is considerably above the average, even for the heavy (140 pounds or over per foot) stone.

(*c*) That the lowest of the Kanawha on edge is above the average of all in the report, and but little under that for the heavy specimens.

The tests of the eight cubes from the Preston and Elk quarries recently made show much lower results.

The averages of all, four on bed and four on edge as given, are:

	Pounds.
On bed	42,000
On edge	43,000

The Elk stone on bed are both reported lower than on edge; this, taken in connection with the former tests from the same quarry, make it appear probable that the beds and edges have been confounded, either by the cutter in marking or in the record. So considered the averages stand:

	Pounds.
On bed	45,500
On edge	39,500

Notwithstanding all of General Gillmore's tests show that a wide range must be allowed for among good specimens from the same quarry, there appears to be too much difference between these eight blocks and those sent by Captain Turtle. Both of those first sent from Elk (all practically from the same ledge), tried on bed, show very high results, and the weight and appearance of the Preston stone would lead one to expect a strength from it, on bed at least, up to the average of the Kanawha stone. The crushing surface used for the eight blocks are not given. If of wood, considerable of the discrepancy could be accounted for. The fact that the eight blocks were just from the quarry and not well seasoned as the first will account for part of the difference.

Though the results from the eight cubes are so much lower, it appears they still rank among and above the average of the strongest sandstones mentioned in General Gillmore's report.

Itappears from other authorities consulted—Mahan (Civil Engineer, pages 71, 72, etc.) Haswell, Trautwine, etc.—that the weakest of the Kanawha stone thus far tested rank with, and generally much above, the strongest examples of European and American sandstones given.

All of the Kanawha specimens considered above (except the four from Preston's) were taken from the well-developed quarries from which Lock 3 and locks and dams 4 and 5 were built. They were selected from among the good stone, and were no doubt considerably above the average of the face stone used in these works. It appears, however, that over 25 per cent. of these selected, and mostly seasoned blocks, broke below the strength required for No. 6.

Though the tests so far made do not show any regular decrease in the strength of the stone as we descend the valley, geologically the formation becomes newer, and experience proves that the stone in the upper part of the valley is harder and better than in the lower. It is safe to say that no stone will be found below Charleston better than that furnished by the Elk quarries, and it is probable that none will be found as good. This stone has been quite extensively used in Lock 4 and in Lock and Dam 5 for almost all the different purposes. It has been considered among the best employed for important parts, as coping, corners, sills, etc.

As regards weight, further comparison of the Kanawha tests with General Gillmore's report shows that the lightest of our stone considered above are equaled by that from but three quarries mentioned, and excelled by but one—a calcareous sandstone from Minnesota. It also appears that the ratio of absorption in all of the Kanawha stone is low.

All considered, it seems that so far as any of these conditions are concerned any of the good acceptable (as heretofore interpreted) stone, in this part of the valley at least, is quite sufficient for our purposes and it appears doubtful whether it is necessary or expedient to require them. With or without such conditions, experience

teaches the necessity of careful inspection as well as the distinct understanding that only such stone will be admitted as are in all respects satisfactory to the engineer in charge.

If, however, conditions as to strength, etc., are considered advisable, it seems evident that the interests of all concerned require them to be materially lowered.

Owing to the discrepancy of the data now at hand, it is impossible to fix upon the proper requirements till more trials of strength have been made.

For the present the following suggestions are submitted: The contractors of Lock 6 want to begin work in the Elk quarries at once, and are also looking towards the Smith quarry (No. 9 of first Kanawha table) and the Ruffner quarry (No. 11 of table) and I respectfully recommend that they be given such assurances regarding the use of this stone, as employed at Locks Nos. 4 and 5, as will enable them to proceed at either or all of these quarries without delay.

Very respectfully, your obedient servant,

A. M. SCOTT,
Assistant Engineer.

Capt. E. H. RUFFNER,
Corps of Engineers, U. S. A.

F F 2.

OPERATING AND CARE OF THE LOCKS AND DAMS ON THE GREAT KANAWHA RIVER, WEST VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., July 9, 1889.

GENERAL: During the last fiscal year the expense of operating the locks and dams on the Great Kanawha River in West Virginia has been paid in the manner indicated by section 4, act of July 5, 1884.

In compliance with the proviso to that section which requires the rendition of an itemized statement of such expenses, I have the honor to forward the inclosed paper.

Very respectfully, your obedient servant,

THOMAS TURTLE,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

STATEMENT OF AMOUNT EXPENDED DURING THE FISCAL YEAR ENDING JUNE 30, 1889, OUT OF THE GENERAL APPROPRIATION FOR "OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION" IN OPERATING AND KEEPING IN REPAIR THE LOCKS AND DAMS ON THE GREAT KANAWHA RIVER, WEST VIRGINIA.

Lock and Dam No. 2:		
For wages of regular lock hands	$2,004.24	
For repairs and extra labor	127.21	
For supplies, as paints, oils, fuel, tools, etc	151.35	
For freights and transportation	4.16	
		$2,286.96
Lock and Dam No. 3:		
For wages of regular lock hands	2,034.34	
For repairs and extra labor	2,600.15	
For supplies, as paints, oils, fuel, tools, etc	90.21	
For freights and transportation	19.20	
		4,743.90
Lock and Dam No. 4:		
For wages of regular lock hands	2,025.92	
For repairs and extra labor	130.49	
For supplies, as paints, oils, fuel, tools, etc	69.99	
For freights and transportation	5.05	
		2,231.45

Lock and Dam No. 5:		
For wages of regular lock hands	$2,007.50	
For repairs and extra labor	320.05	
For supplies, as paints, oils, fuel, tools, etc	99.93	
For natural gas to light works	38.67	
For freights and transportation	7.11	
		$2,473.26
Lock and Dam No. 6:		
For wages of regular lock hands	1,982.00	
For repairs and extra labor	77.55	
For supplies, as paints, oils, fuel, tools, etc	119.29	
For freights and transportation	.90	
		2,179.74
Superintendence and central office expenses:		
Wages	3,007.49	
Rent and supplies	269.83	
Freights and transportation	16.25	
		3,293.57
Dredging at locks; and part of running expenses of steam-boat:		
Wages	1,458.40	
Repairs and supplies	92.33	
		1,550.73
Telephone line:		
Rent of instruments	155.00	
Repairs and supplies	307.74	
Freights and transportation	33.00	
		495.74
Gauge reports:		
For pay of gauge keepers and reporters at Hinton and Kanawha Falls	144.00	
		144.00
Total		19,399.35

F F 3.

IMPROVEMENT OF ELK RIVER, WEST VIRGINIA.

During the preceding fiscal year nothing was done, as the amount available was too small to enable operations to be carried on economically. By the act of August 11, 1888, $3,000 was appropriated, increasing available funds to $4,500. As soon as practicable, operations in continuation of those heretofore carried on, of clearing the stream of rock, logs, brush, and other obstructions impeding the floating of logs down-stream, and of constructing wing-dams where needed, were commenced.

The report of the overseer, giving in detail the work performed and the localities where it was done, is appended hereto.

Money statement.

July 1, 1888, amount available	$1,500.00
Amount appropriated by act of August 11, 1888	3,000.00
	4,500.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	3,925.11
July 1, 1889, balance available	574.89
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,500.00

REPORT OF MR. W. A. PORTER, OVERSEER.

ADDISON, WEBSTER COUNTY, *December* 30, 1888.

COLONEL: On the 23d of August I went to Charleston to consult with Mr. A. M. Scott, assistant engineer, and on the 13th of September returned to the Upper Elk, near the lower line of Webster County, where Mr. H. H. Beall had been at work for a few days. The instructions were for me to take charge of this part of the river, and Mr. Beall moved some miles down, in the neighborhood of the mouth of the Holly River, to do some work there. A report of the work done by Mr. Beall is also given below. We were not able to do much for a few days, on account of high water, but this gave a chance to get things in order, arrange for camp, get a crew of men and a smith with his tools on the ground. We had no trouble in getting plenty of good men. Wages were 12½ cents per hour. We started to work at Miller's Ford on September 17, and the work progressed very nicely for several days, when we were detained by another rise. There were three good log-tides during the time we were at work, and several small ones; this, with the wet, bad weather, kept us back very much.

Mr. Scott met me at Addison September 21, and on the 22d and 23d we went down the river, making close observation from that place to where we were at work, a distance of about 15 miles.

His instructions were to clean this part of the stream of the worst rocks, for the purpose of floating timber and logs. A channel about 25 feet wide was cleared. In some places, on account of short bends or rapid water, the channel was made somewhat wider than 25 feet.

There is a large quantity of timber on Upper Elk waters that could successfully be put in market if the stream was improved so logs could be driven. Without improvement, all or nearly all of the timber put in the upper river is so long on the way that it is much damaged before it gets down, and a considerable per cent. of what has been put in in the past is now lying along the river, decayed and worthless.

Our first work was with powder, and, not having much on hand, a team was sent to Philippi, a distance of 80 miles, for dynamite, which we found, after a trial, much better for our work, as it crushed the rock much finer than powder, thus making less drilling.

In the start we did not have tools enough to work as many men as instructed. More tools were ordered at once, but, being so far from the railroad, it was about twenty days before they came.

The following is a detailed account of work done during the season. That done under Mr. H. H. Beall, overseer, being mostly in Braxton County, above Sutton, is given first.

Mr. Beall having gone to Charleston with a canoe, left there on September 2, with tools, steel, and supplies. On the 7th, arrived at Sutton, where he got drills made and things in order for going to work. On the 11th, commenced work near "The Gulf," about 20 miles above Sutton; blasted some rock, aggregating about 11 cubic yards, and cut some timber and brush on a bar near by. The next day, passed by some work to Mines Island, about 24 miles above Sutton. This is a bad place for logs to lodge. It is a long narrow channel behind the island, and filled with large rock. He worked here blasting out the worst rock until the 15th, when I took charge of this part of the river, Mr. Beall moving down the river to Spring Ford, and repaired the dike there.

Widows Island.—Cut and removed some brush and timber.

Salisbury Shoal.—Nine and one-half miles above Sutton. Blasted and removed three rocks aggregating about 150 cubic yards.

Persimmon Island.—Ten miles above Sutton. Cut and removed brush.

Old Lick Shoal.—Nine miles above Sutton. Two riprap dikes were built; one 132 feet long, 8 feet wide, and 5 feet high; the other 68 feet long, 10 feet wide, and 6 feet high. Also, blasted 20 rocks aggregating about 140 cubic yards.

Tower Falls.—Seven and one-half miles above Sutton. Two low dikes of logs and brush filled with stone were built here; one 80 feet long, the other 40 feet long; one rock blasted aggregating about 60 cubic yards.

Buck Elk Island.—Three miles above Sutton. At this place a V-shaped dike was built to keep timber from stopping on the head of the island. One wing is 56 feet, and the other 78 feet long. It is a strong crib of small, sound, white oak timber 7 feet high (10 feet wide at bottom and battered on back to 7 feet top width), drift-bolted together and filled with stone. About 1,500 lineal feet of sound timber and 160 drift-bolts were used in its construction. In log-rises that occurred in November the dike was found to work well, though it will probably be advisable to extend somewhat the river wing. Some brush and small trees liable to stop timber were also cut from the lower part of the island.

Gillespie's Dam.—Seven miles above Sutton. A low dike, 287 feet long, extending out from the left bank, was built here to keep logs off from a high bar below the

dam. From the shore end 182 feet down the dike was made of logs and brush filled in with stone. The remaining 105 feet were built of loose stone picked up on the bar. It is about 4½ feet high and 10 feet wide on the bottom. It is reported to have worked well in the log-rises that have occurred since it was built.

Four rocks were blasted from the bar outside of the dike that aggregated about 50 cubic feet.

Union Mills Island.—Thirteen and a half miles above Sutton. A crib-dike was built out from the right bank at the head of the island to keep timber from stopping in the side channel and on the island. This was one of the most troublesome places to lumbermen on the river.

The dike, including a wing 40 feet long at the shore, is 522 feet long. It was built of round white-oak timber, drift-bolted and filled with stone. It is 10 feet wide at the bottom, battered to 8 feet top width. Its average height is about 6 feet, the top being about 8 feet above low water. In building it 5,260 lineal feet of oak timber, 450 drift-bolts, and about 750 cubic yards of stone were used.

LOWER ROCK CAMP, 12 MILES BELOW SUTTON.

By the request of several prominent lumbermen, Mr. Beall was sent to remove brush and trees from an island and bar at this place, which is said to be the worst place below Sutton to stop logs. The work was done from December 3 to 8. This closed Mr. Beall's work for the season.

A detailed report of the work done in the upper part of the river (in Webster County, below Addison), at clearing a channel through the shoals by blasting loose rock and bowlders, here follows. The location of the different points where work was done, the number of blasts fired, quantity of rock blasted, etc., is given in the accompanying table.

Miller's Ford.—Work, as before stated, was commenced at this point on September 17. Two rocks were blasted and scattered in deep water.

Wood's Defeat.—Three rocks were blasted. There should be a dike built here to keep logs out of a bad pocket behind the island in high water.

Soon Rock.—Seventeen rocks were blasted and leveled with the water.

Rocky Riffle.—This, as its name indicates, is quite rough and rocky, and about 100 rods long. We made a narrow channel through it, blasting altogether fifty-one rocks.

Bee Run Gulf.—Eleven rocks were blasted and scattered in deep holes.

Sam Mack Notch.—Fifteen rocks were blasted and scattered over the river.

Rocky Ford.—Blasted and leveled with the water twenty-six rocks, and a short distance above this eighteen rocks were blasted. A crib or dike is needed here, and it might be necessary to have one at the head of the island.

Peach Orchard.—The river here was almost closed with rocks. They extended from the right bank almost across the river, and about 20 yards below they extend beyond the middle from the other side, with scattered rocks in the river. Fifty-one rocks were blasted, and a large amount of them had to be carried some distance to get them leveled with the water.

Black Water Ford.—Ten rocks were blasted and scattered.

Mulberry Island.—Twenty-four rocks were blasted. A dike is needed here to turn logs to the right of the island. When they go to the left they drift on a long, high bar.

Mulberry Shoal.—Seventeen rocks were blasted and thrown where water could be found deep enough to cover them.

Black Water Pond.—Twenty-one rocks were blasted. One measured 222 cubic yards. A short training-wall was built 4 feet high with part of the rock blasted. The greater portion of the large rock had to be carried a distance to find a place to deposit.

Wash Rock Shoal.—Forty-seven rocks were blasted and scattered over the river.

"Old Andy" Ford.—Nineteen rocks were blasted and removed. A dike is badly needed at this place. About 200 logs are lodged here.

Griffin's Island.—Distance from here to "Old Andy" Ford is about 2 miles, and there is some scattered work left. We passed over this during high water to some larger rocks, and the cold weather prevented our going back. Ten rocks were blasted here. This is a very bad place for logs to lodge. A dike should be built on the right a little below Mr. Cochran's house.

Big Run Shoal.—One hundred and two rocks were blasted and scattered about in water. One rock contained 300 cubic yards.

Mill Run and Canoe Tree Shoals.—Seventeen rocks were blasted and removed.

Rocky Hole.—Fourteen rocks were blasted and rolled in deep water.

Painter Lick Shoal.—This shoal has the largest rocks of any shoal on the river, and more of them. It is about a mile long. Fifty-five rocks were blasted and scattered, the largest one containing 565 cubic yards. This shoal was not finished, the cold

weather preventing. We stopped work on November 24, 5 miles below Addison. All the property belonging to improvement in my hands was stored at Mr. J. W. Tracy's, near this shoal, and left in his care.

Very respectfully,

W. A. PORTER,
Overseer.

Col. W. P. CRAIGHILL,
Corps of Engineers, U. S. A.

Table showing approximate distances above Sutton (Braxton Court House) of points where rocks were blasted under W. A. Porter, overseer, the number of rocks worked on, holes drilled, blasts fired, and approximate cubic yards blasted.

Name of shoal.	Miles above Sutton.	Rocks blasted.	Holes drilled.	Total blasts fired.	Cubic yards of rock blasted (approximate).
Miller Ford	23	2	11	.....	166
Wood's Defeat	23½	3	8	.....	32
Soon Rock	24	17	14	.....	50
Rocky Riffle	24½	51	61	.....	124
Bee Run Gulf	24½	11	31	.....	225
"Sam Mack Notch"	25	15	21	.....	23
Rocky Ford	26	24	59	.....	135
Peach Orchard	26½	51	160	.....	447
Black Water Ford	27	10	15	.....	25
Mulberry Island	27½	24	52	.....	163
Mulberry Shoal	27½	17	31	.....	139
Black Water Pond	28	21	66	.....	284
Wash Rock Shoal	28¼	47	87	.....	426
"Old Andy" Ford	29	19	34	.....	184
Griffin's Island	31	10	28	.....	326
Big Run Shoal	32	102	189	.....	747
Mill Run and Canoe Tree Shoals	33 / 33½	17	29	.....	83
Rocky Hole	33½	14	52	.....	333
Painter Lick Shoal	34	55	191	.....	1,202
Total	.....	510	1,139	1,189	4,961

[A number of rocks were blasted without drilling, which accounts for "the number of blasts fired" being in excess of "holes drilled."

ELK RIVER.—COMMERCIAL STATISTICS.

U. S. ENGINEER OFFICE,
Charleston, W. Va., July 20, 1889.

CAPTAIN: I have the honor to submit the following statistics of the timber business of Elk River for the year ending June 30, 1889, from information collected by this office. The statistics for previous years from your former reports to the Chief of Engineers are also included in the table:

Year.	Saw-logs and lumber (feet B. M.)	Railroad ties.	Oak staves.	Hoop poles.	Shingles.	Hickory spokes.
1883	5,200,000	100,000	898,334	.....	.....	.....
1884	5,975,000	125,000	1,222,500	.....	.....	.....
1885	5,100,000	150,000	1,433,750	.....	.....	.....
1886	15,361,000	250,000	1,845,000	.....	.....	.....
1888	15,900,000	330,000	1,210,000	300,000	.....	.....
1889	15,750,000	295,000	1,600,000	500,000	2,000,000	350,000

All of this comes down the river to or past Charleston. Of the "saw-logs and lumber," the logs form much the greater part, and the most of them are sawed by the mills here.

It is estimated that about 70 per cent. of the lumber cut during the past year was plar, the rest being mainly oak, hemlock, walnut, and ash.
About 60,000 pounds of wool and 20,000 bushels of wheat were marketed at Charles- a from the Elk Valley during the year.

Very respectfully, your obedient servant,

ADDISON M. SCOTT,
Resident Engineer.

Capt. THOMAS TURTLE,
Corps of Engineers, U. S. A.

F F 4.

IMPROVEMENT OF GAULEY RIVER, WEST VIRGINIA.

Operations for the improvement of the Gauley River were instituted r examinations made in 1887, in accordance with the provisions of the ver and harbor act of August 5, 1886. As a result of those examina- ons it was pointed out that a valuable improvement of the 12 miles of ver from the mouth to the "Roughs" could be made at an expense $10,000, and that great advantage would follow the expenditure of 5,000 in the 26-mile reach called the "Roughs," in facilitating and eapening the bringing to market of millions of feet of lumber of the ost valuable and varied kinds.

The river and harbor act of August 11, 1888, appropriated $3,000 for eaning out the channel. The project approved for the expenditure of is small sum contemplated the removal of ledges of solid rock and e making of channels through 18 shoals of loose rock and boulders, mmencing at Cripple Creek, about three-quarters of a mile above the outh and extending to the pool above Rich Creek, a distance of 10 miles. ie work was carried on by the hire of labor and the purchase of ma- rials in open market, the circumstances not permitting contract work m considerations of economy and advantage.

The details of the work accomplished appear in the report of Mr. Will- m Proctor Smith, appended hereto. The total expenditure to date has en $1,266.42, and the balance, $1,733.58, will be expended toward the mpletion of the project later in the season, when circumstances permit.

Money statement.

ount appropriated by act of August 11, 1888	$3,000.00
ly 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	1,266.42
ly 1, 1889, balance available	1,733.58
Amount (estimated) required for completion of existing project	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	7,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. WILLIAM PROCTOR SMITH, ASSISTANT ENGINEER.

BALTIMORE, MD., *December* 5, 1888.

COLONEL: I have the honor to report the following operations on Gauley River, est Virginia:

The project calls for a bateau channel 30 feet wide and 2 feet deep at ordinary low ter, from the mouth to a point 10 miles up the river.

To carry this out work was begun on the 2nd of October with a few hands, and sed out on the 5th of November.

Owing to the lumbermen and boatmen's anxiety to get the channel-way improved as up as possible, and to the lateness of the season, the channel width, with your

approval, was reduced to 20 feet, which width can be increased at any time it may be desired without extra cost.

The natural sluice-ways previously used by the boats were also adopted for reasons above assigned and also because the work would be lighter.

A commencement was made at Scrabble Creek ledges, one-fourth mile above mouth of river.

The channel was located and made through the old bateau chute, in which were encountered five broken ledges, a part of the main ledge, and a large rock at the head, all of which were blasted out and the loose stone made into a wall at the upper end of the channel; the stone at the lower end not being removed owing to the difficulty in obtaining a rock-boat at the moment and the subsequent rise of the river. These stones can be cleaned out with the labor of about eight men one day, and then the channel will be complete. About 12 cubic yards in all were blasted.

As it is now, navigation is much improved by the removal of the obstructions at its entrance and by the straightening of the channel at the middle.

The ledge other than at the channel, which is 150 feet in length, with actual work for 70 feet, is compact and unbroken and extends for at least 175 feet up and down stream.

The next work was at Buck's Ford Ledges, two-thirds of a mile from mouth of river. These ledges are in three groups extending over a distance of 700 feet, with actual work for a distance of 120 feet, through nine smaller ledges; from which were taken and built into walls about 40 cubic yards of material.

Owing to high water, however, all of the obstructions were not removed, but it is thought that the labor of twenty men one day will complete it.

This channel, too, is much improved in directness, and the worst of the ledges have been taken away.

The channel through these shoals would be more direct by going along the left bank, and would have been so located had the work not been regarded as being too heavy and expensive.

The rock is yellow sandstone for 6 inches, then gray, interspersed with flint and river pyrites, and very hard to drill.

The fall over Scrabble Creek and Buck's Ford ledges is estimated at 2 feet each.

Getting through these ledges gives outlet to Big Creek, nearly 2 miles above the mouth of the river, and finishes up the solid rock work, for the shoals above are composed of loose rock and gravel with here and there a bowlder to be blasted.

Average work 10 men 7¼ days of 10 hours, at 15 cents per hour. Largest number of laborers at one time, 16. Men were few and new to this kind of work.

It rained eighteen out of the thirty working days.

Five distinct rises occurred during the working period with heights ranging from 1.9 feet to 8.2 feet.

Such a wet October had not been seen for seven years.

Gauge-reading varied from 0.7 feet below to 7¼ feet above zero or ordinary low water.

After the rise of 5.3 feet on the 12th of October, operations in the river practically ceased, for the water never again got down to zero of the gauge or working-point.

Some of the tools were borrowed from the Kanawha River improvement and returned when the work closed out, the remainder were purchased in Charleston and are now stored at Gauley Bridge, W. Va.

Two canoes and one rock-boat were hired for one month.

The powder used was "Ajax," 40 per cent. nitro-glycerine.

A water-gauge was put up about 100 feet above Buck's Ford Ledges, out of the way from backwater from New River.

There are a few rock at the junction of the Gauley and New rivers, in the way of boats going to Gauley Station, Chesapeake and Ohio Railway, which should and can be removed at a cost of about $15.

New River, during the continuance of the work, was always muddy, but the Gauley rarely so, its waters having a dark tinge, supposed to be given by the leaves on its banks from the forest trees.

The lines of the two streams were distinctly marked for a long distance after they found the Kanawha River.

Gauley is a village at the mouth of the river, on the right bank, of about 100 souls, with two stores and two livery stables.

The abutment and two piers of an old bridge are still standing at the mouth of the river. The bridge was 488 feet in length, with spans of 66¾ feet.

A ferry is in operation from Gauley to the left bank of the stream, and also one from Gauley to Gauley Station, Chesapeake and Ohio Railway, on left bank of New River.

The Gauley and New River form the Kanawha at this point, 2 miles above Kanawha Falls.

Big Creek, Twenty-Mile, and Little Elk Creek empty into the Gauley on the line

of this improvement, from the right, respectively 1¼, 5, and 9 miles from its mouth, and Rich Creek from the left, 8 miles from the same point.

There are two saw-mills in operation on Rich Creek, and the same number on the tributaries on Twenty-Mile.

For the year ending the 31st October, 1888, 4,100,000 feet of lumber, 1,100,000 feet of logs, 150,000 staves, and 150,000 pounds of produce, such as butter, eggs, wool, ginseng, etc., were brought down the Gauley River and shipped east and west from Gauley and Kanawha Falls stations, Chesapeake and Ohio Railway.

To carry this lumber four boats and two bateaux are in use. The boats are 80 feet long, 6 feet 9 inches wide, and 1 foot 6 inches deep, with a capacity of 8,000 feet, and the bateaux will carry about the same. In the same year 1,500,000 pounds of general merchandise, staves, furniture, organs, etc., were received at Gauley and sent into Webster and Nicholas counties, West Virginia.

This section is full of bituminous coal, and a large amount of the finest of timber of every variety, for a full description of which and other information reference is made to your report to the Chief of Engineers, U. S. Army, December 26, 1887.

A tracing of a map of Gauley River, showing the work for this season in detail, made to a scale of 200 feet to the inch, accompanies this report, as well as a tracing of a skeleton map, scale 1 mile to the inch, of a railroad survey made in the spring of 1882, under the direction of H. D. Whitcomb, civil engineer, up the Gauley and Williams rivers to the Greenbrier River, in Pocahontas County, West Virginia.

From this map was obtained the general outlines of the map whose tracing is herewith presented, the details being obtained by actual measurements on the grounds.

Respectfully submitted.

WILLIAM PROCTOR SMITH,
Assistant Engineer.

Col. W. P. CRAIGHILL,
Corps of Engineers, U. S. A.

F F 5.

IMPROVEMENT OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

After a suspension of operations for some years for want of funds an appropriation of $10,000 was made August 5, 1886, applicable, however, only to the portion of the river above the lead mines in Wythe County, Va.

Doubt having arisen, in view of the changed condition of affairs on and near the river, as to the propriety of expending this appropriation at once, it was decided by proper authority to defer operations until the will of Congress could be further ascertained.

In the river and harbor act of August 11, 1888, it was directed that the balance should be spent in improving the river between Ivanhoe Furnace, in Wythe County, and the mouth of Wilson Creek. Operations in accordance with this direction have commenced.

For details reference is requested to attached report of Mr. William Proctor Smith, assistant engineer.

Money statement.

July 1, 1888, amount available	$10,147.29
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	1,411.05
July 1, 1889, balance available	8,736.24
Amount (estimated) required for completion of existing project	159,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. WILLIAM PROCTOR SMITH, ASSISTANT ENGINEER.

IVANHOE FURNACE, WYTHE COUNTY, VA., *June* 14, 1889.

CAPTAIN: I have the honor to report the following operations on the improvement of New River, Virginia and West Virginia, for the fiscal year ending June 30, 1889.

In January, 1889, a project for the expenditure of the appropriation for the improvement of New River, Virginia, between Ivanhoe Furnace, in Wythe County, and

the mouth of Wilson Creek, was submitted to the Chief of Engineers, U. S. Army, and approved. This project calls for a channel 20 feet wide and 2 feet deep at ordinary low water and also provides for straightening and otherwise improving such portions of the channel needing it, already worked on in 1881 and 1885, rendered necessary by the adoption of a line of improvement for rafts, which require more directness of course than that for bateaux, and to extend the channel up the river as far as the funds will permit.

Ivanhoe Furnace, the initial point, is nearly 3 miles above the Lead Mines, the former point of departure, in Wythe County, Va., and 46 miles, by river, from the bridge where the Norfolk and Western Railroad crosses New River, and is connected with the Norfolk and Western Railroad by the Cripple Creek branch road, 32 miles long, at Pulaski, Va., making the distance from New River Bridge, by rail and water, about the same.

To ascertain whether the materials for building boats and labor could be procured for carrying out the project above referred to an assistant engineer was sent to Ivanhoe in March. His report being favorable, instructions were given him to begin preparations for the same early in May, which he did by building canoes and rock-boats and establishing camp about 4 miles above Ivanhoe and about half the distance the work will cover this season, commencing on the 4th of the month and finishing on the 28th. Next day it began to rain very hard, and on the 31st the river rose 15 feet and did not fall low enough to begin operations until Sunday, the 9th of June. Monday, the 10th of June, the work began with 73 men all told, divided into three parties. One party made a channel 30 feet wide and 2 feet deep through Rowe's Shoals, one-seventh of a mile above, and through Porter's Ford, two-thirds of a mile above Ivanhoe Furnace. These shoals are composed of loose rock and gravel and had filled up considerably since the formation of the project, two years ago; the greater width was given to secure future stability. About 35 cubic yards of material was removed from these shoals and built into walls. The former is in Wythe and the latter in Carroll County.

The other parties worked at the first and second ledges of Roger's Shoals, 1.4 miles above the initial point. This work consisted principally in drilling and blasting, the material from which could not be removed owing to another rise in the river, during the night, of 1 foot. The 11th, one party moved up to Wilkinson's Forge, but could do no work. The rains have continued to date and the river is now 1.4 feet above zero and very muddy. Not a clear day since the 1st of June.

A few men have been and are now being employed in taking care of boats and other property, putting up shelters for men, building coal and powder houses and blacksmith's shops, and having camp put in good shape, so that everything will be in readiness to carry the work on rapidly when it does begin.

So much has already been said in former reports in the way of describing this section that it is not thought necessary now to add anything.

Respectfully submitted.

WM. PROCTOR SMITH,
Assistant Engineer.

Capt. THOMAS TURTLE,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Statement of tonnage received at and sent from Ivanhoe Station, Cripple Creek Railroad, Wythe County, Virginia, during the fiscal year ending June 30, 1889 (in tons of 2,000 pounds).

Articles.	Received.	Sent.	Articles.	Received.	Sent.
Coal oil ..... barrels..	192	.....	Coal ..... tons..	1,680	.....
Flour ..... do....	450	.....	Coke ..... do....	428	.....
Manufactured tobacco.. tons..	4½	.....	Iron ore ..... do....	6,600	.....
Manufactured iron ... do....	60	.....	Pig-iron ..... do....	.....	2,600
Miscellaneous freight*.. do....	300	120			

* One-tenth received went to, and one-half sent came from, New River.

New River supplied the furnaces and village with 250,000 bushels of charcoal, 850 cords of wood, and 300,000 feet of lumber in the above period.

The village of Ivanhoe has about 600 inhabitants, 5 stores with sales averaging $8,000, and a carpenter shop doing a business of $16,000 per annum.

At present only canoes are in use on this part of New River.

APPENDIX G G.

IMPROVEMENT OF TRADEWATER, KENTUCKY, AND LICKING RIVERS; OPERATING AND KEEPING IN REPAIR LOCKS AND DAMS ON THE GREEN AND BARREN AND KENTUCKY RIVERS, KENTUCKY; IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY, AND OF GUYANDOTTE, LITTLE KANAWHA, AND BUCKHANNON RIVERS, WEST VIRGINIA.

REPORT OF MAJOR D. W. LOCKWOOD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Tradewater River, Kentucky.
2. Operating and keeping in repair locks and dams on the Green and Barren rivers, Kentucky.
3. Kentucky River, Kentucky.
4. Operating and keeping in repair locks and dams on the Kentucky River, Kentucky.
5. Licking River, Kentucky, from Farmers to West Liberty.
6. Big Sandy River, West Virginia and Kentucky.
7. Guyandotte River, West Virginia.
8. Little Kanawha River, West Virginia.
9. Buckhannon River, West Virginia.

EXAMINATION.

10. Big Sandy River, Kentucky, from Catlettsburgh to Pikeville, on the Louisa Fork and to the mouth of Pond Creek on Tug Fork.

UNITED STATES ENGINEER OFFICE,
Cincinnati, July 13, 1889.

SIR: I have the honor to transmit herewith the annual reports on the works under my charge at the close of the fiscal year ending June 30, 1889.

First Lieut. William L. Sibert, Corps of Engineers, has been on duty under direction of this office throughout the year.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

G G 1.

IMPROVEMENT OF TRADEWATER RIVER, KENTUCKY.

This work was in charge of Maj. Amos Stickney, Corps of Engineers, until September 5, 1888, when it was transferred to my charge.

The Tradewater is a tributary of the Ohio, and empties into it 79 miles below Evansville, Ind. The project for its improvement adopted in April, 1881, contemplated originally the removal of obstructions such as bars, snags, etc., so as to open up to navigation 22 miles of the river by forming a channel with a minimum width of 40 feet and a minimum depth of 2½ feet for 8 months of the year.

The survey upon which the project was based covered 41 miles of river and the scope of the work has been extended to embrace this.

The fall of the river in this 41 miles is 27 feet, and Captain Cuyler, in his original report on the subject, stated that the only effective method of improvement of a permanent character was by the slack-water system of locks and dams. The plan adopted, however, was that of clearing the banks of overhanging trees, and the channel of rocks, snags, etc., which would insure a navigation of moderate depth whenever there was any water in the river.

Up to the end of the last fiscal year the following work had been done:

First. A channel 40 feet wide and 2½ feet deep had been blasted out through the rock-bar near the mouth.

Second. The obstructions in the channel had been cleared out for a distance of 24½ miles up-stream from the mouth.

Third. The banks had been cleared for a distance of 14 miles and the timber deadened for the remaining 27 miles covered by the improvement.

As the object of the improvement is to increase the low-water depth, it is essential that work should be done at as low a stage of water as possible. During the past fiscal year the water was too high for effective work, and in consequence nothing was done. It is proposed, however, to put the plant in such shape that advantage may be taken of any low stage.

It is proposed to complete the improvement with the money now available and no additional appropriation is therefore asked for.

Money statement.

July 1, 1888, amount available		$371.54
Amount appropriated by act of August 11, 1888		6,000.00
		6,371.54
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$65.00	
July 1, 1889, outstanding liabilities	2.10	
		67.10
July 1, 1889, balance available		6,304.44

Commercial statistics for fiscal years ending June 30, 1888 and 1889.

Articles.	1888.	1889.	Articles.	1888.	1889.
Coal..... bushels..	973, 580	220, 537	Hogs..... head..	3, 210	
Wheat..... do....	214, 350	.....	Beef cattle..... do....	732	
Corn..... do	62, 374	12, 375	Sheep..... do....	472	
Flour ..... barrels..	17, 389	.....	Eggs.....dozen..	3, 478	
Tobacco ..... pounds..	178, 480	22, 500	Poultry..... do....	978	
Lumber, sawed.feet B. M..	2, 537, 475	1, 371, 375	Miscellaneous freight,		
Lumber, logs.....do....	1, 347, 534	632, 745	value	$84, 493. 75	$25, 375
Staves... ..... number..	275, 000	534, 564	Hoop-poles.... number..		37, 375
Potatoes..... barrels..	4, 730				

G G 2.

OPERATING AND KEEPING IN REPAIR THE LOCKS AND DAMS ON THE GREEN AND BARREN RIVERS, KENTUCKY.

The river and harbor act of 1888 contained the following:

For the purchase of the improvements known as the Green and Barren river improvements, one hundred and thirty-five thousand dollars: *Provided*, That no part of said sum shall be expended until a full and absolute conveyance of said improvements, together with rights of way, easements, piers, docks, and appurtenances of every nature, belonging to or connected with said improvements, by the owner or owners thereof, and the Attorney-General of the United States shall have certified to the Secretary of War that the title is perfect.

At the time of the passage of the act the Green and Barren River Navigation Company had possession of the improvements by virtue of a lease from the State of Kentucky, which had still ten years to run.

The deed transferring the improvements, etc., to the United States having been executed, and the Attorney-General having certified to the title, the purchase money was paid the Navigation Company December 11, 1888, and the United States took possession of the improvements, which consisted of four locks and dams in working order, and one broken lock (the river-wall down), with dam. The broken lock was No. 3 Green, and all freight up and down the river passing it had to be transferred over it. The river-wall of the lock had fallen into the river about the first of the year, and its yielding was doubtless due, principally, to the poor quality of stone and cement used in its construction. Of the four other locks, No. 1 Barren was liable to fail at any time, as the lower end of the land-wall had cracked and opened near the upper end of the gate recess, and also at the junction of land and lower wing-wall. The detached portion inclined toward the lock-pit, and was anchored back to the lower wing-wall by iron straps bolted to the masonry.

No. 2, Green River, was also in a very bad shape, both walls being badly cracked, the land-wall especially so, and held in place by being anchored back to cribs filled with stone. The river-wall had yielded outwward. The two remaining locks were in fairly good condition.

As soon as the river reached a proper stage, work was commenced clearing away the fallen wall at No. 3. It had been hoped that a great deal of the stone could be used in building the new wall, but most of it was found to be too soft and friable for that purpose, and only a small part can be used for backing.

The cement formerly used in the construction of this wall was in many places not as good as ordinary common lime. At the end of the fiscal year the wall had been nearly all removed and a dipper-dredge was at hand to clear the site for the coffer-dam. Contracts have been

made for the stone required at Lock No. 3, Green River, and at No. 1, Barren River; also for two lock-keepers' dwellings at No. 1, Green River, one at No. 2, two at No. 3, one at No. 4, and two at No. 1, Barren River.

A contract has also been made for the construction of a suitable snag-boat at a cost of $18,400. It is estimated that, working during low-water seasons, it will take two or three years to remove the snags, etc., that exist in the two rivers. Lock No. 2, Green River, should in my opinion be rebuilt. As already stated, the walls are in a dangerous state and liable to give way at any time; to repair them so as to make them reasonably secure would require their being rebuilt practically. In addition, the approaches are long and difficult to maintain, shoaling up as they do during every high water. Lieutenant Sibert estimates that it will cost $4,000 annually to keep these entrances open. I would therefore recommend that a new lock be constructed on a different site from that occupied by the present one, the best location to be determined by careful surveys, and that the lock be of the same capacity as the one on the Big Sandy River, to wit, length between quoins, 190 feet; width of chamber, 52 feet. The estimated cost of this lock, with dam and masonry abutment complete, was $213,237.39, and it is believed that the cost on the Green River will be about the same. As the estimated cost of the lock itself is $155,000 about, I would respectfully recommend that this amount be appropriated in one sum, in order that the construction of the lock entire may be placed under contract at one time.

Since January 1 two decked barges, two derrick-boat hulls, and one hull for dredge have been built by hired labor.

Under the management of the Navigation Company leases of water power were granted to outside parties, and it is very desirable that the officer in charge be allowed to do the same; the surplus water not needed for purposes of navigation may thus be made to yield a very considerable revenue to the United States. I would respectfully recommend the passage of an act applicable to the Green and Barren rivers similar to the one in the river and harbor act of 1888, with reference to the Muskingum River, to wit:

> The Secretary of War is hereby authorized and empowered to grant leases or licenses for the use of the water-powers on the Green and Barren rivers at such a rate and on such conditions and for such periods of time as may seem to him just, equitable, and expedient: *Provided*, That the leases or licenses shall be limited to the use of the surplus water not required for navigation. And he is also empowered to grant leases or licenses for the occupation of such lands belonging to the United States on said Green and Barren rivers as may be required for mill-sites or for other purposes not inconsistent with the requirements of navigation; and all moneys received under such leases or licenses shall be turned into the Treasury of the United States, and the itemized statement thereof shall accompany the Annual Report of the Chief of Engineers.
>
> But nothing in this act shall be construed to affect any vested right, if such there be, of any lessee of water-power on said river.

Lieut. William L. Sibert, Corps of Engineers, has been in local charge of the Green and Barren river improvements since their acquisition by the United States, and his report is appended hereto.

It is proposed to apply the allotment for the fiscal year ending June 30, 1890, as follows:

Lock No. 1, Green River.—Raising lock-walls. Constructing lower guide-cribs. Constructing upper guide-cribs. Filling, grading, and paving. Fencing Government land. Completing lock-keeper's dwellings.

Lock No. 2, Green River.—Complete cribs supporting river-wall. Complete lock-keeper's dwellings.

Lock No. 3, Green River.—Complete building lock-wall. Repair and extend dam across river. Fencing Government land. Complete lock-keeper's dwellings.

Lock No. 4, Green River.—Repair lower miter wall and sill. Fencing Government property. Complete lock-keeper's dwelling.

Lock No. 1, Barren River.—Repairs to dam. Repairs to lock-walls. Constructing lower guide-cribs. Complete lock keeper's dwelling.

General work.—Dredging lock entrances when necessary. Removing snags when boat is completed.

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Green and Barren rivers improved by locks and dams during a portion of the fiscal year ending June 30, 1889.

LOCK NO. 1, GREEN RIVER.

Month.	Salaries.	Labor and material.	Dredging.	Current and contingent expenses.	Total.
1888.					
January	$151.66	$18.75		$69.53	$239.94
February	176.00	106.31		27.59	309.90
March	261.04	134.59		55.82	451.45
April	306.72	179.15		57.56	543.43
May	297.60	100.67		78.81	477.08
June		6.94		36.27	43.21
Total	1,193.02	546.41		325.58	2,065.01

LOCK NO. 2, GREEN RIVER.

January	228.16	90.25		69.53	387.94
February	206.00	601.96	95.53	27.59	931.08
March	261.04	513.52	295.42	55.79	1,125.77
April	306.72	1,644.56	210.32	57.49	2,219.09
May	297.60	3,102.85		78.78	3,569.23
June		295.91		36.27	332.18
Total	1,299.52	6,339.05	601.27	325.45	8,565.28

LOCK NO. 3, GREEN RIVER.

January	144.16	20.75		69.53	234.44
February	81.00	1,365.26		27.59	1,473.85
March	166.04	3,020.70	30.05	55.79	3,272.58
April	211.72	4,667.69	45.00	57.49	4,981.90
May	202.60	5,287.76		90.78	5,581.14
June		1,468.36		36.27	1,504.63
Total	805.52	15,830.52	75.05	337.45	17,048.54

LOCK NO. 4, GREEN RIVER.

January	208.67	34.95		69.53	313.15
February	176.00	141.92		27.59	345.41
March	259.54	334.21		55.79	649.54
April	306.72	396.31		57.49	760.52
May	297.60	692.69		78.78	769.07
June		141.18		36.27	177.45
Total	1,248.53	1,741.16		325.45	3,315.14

LOCK NO. 1, BARREN RIVER.

January	144.17	18.75		69.56	232.48
February	131.00	106.31		27.61	264.92
March	225.06	794.56		55.79	1,075.41
April	306.72	118.82		57.49	483.03
May	297.60	619.30		84.59	1,001.49
June		1,284.39		36.29	1,320.68
Total	1,104.55	2,942.13		331.32	4,378.01

RECAPITULATION.

Lock No. 1, Green River	$2,065.61
Lock No. 2, Green River	2,865.29
Lock No. 3, Green River	17,043.54
Lock No. 4, Green River	3,315.14
Lock No. 1, Barren River	4,378.01
Total disbursements for all the locks	35,371.99
Outstanding liabilities June 30, 1889 (unclassified)	11,165.78
Total incurred	46,537.77

Abstracts of bids received and opened April 16, 1889, by Maj. D. W. Lockwood, Corps of Engineers, for construction of keeper's dwellings at Locks No. 1, 2, 3, and 4, Green River, and No. 1, Barren River, Kentucky.

No.	Name and address of bidder.	Green River, Kentucky.				Lock No. 1, Barren River, Kentucky, two houses.	Total.
		Lock No. 1, two houses.	Lock No. 2, one house.	Lock No. 3, two houses.	Lock No. 4, one house.		
1	Choate & Brawner, Frankfort, Ky	$3,842.10	$1,921.05	$3,842.10	$1,921.05	$3,842.10	$15,368.40
2	Hunt & McLain, Auburn, Ky	.....	.....	5,035.20	2,328.62	4,587.24	11,951.06
3	J. Tom Williams & Bro. Bowling Green, Ky	3,100.00	1,550.00	2,940.00	1,470.00	2,940.00	12,000.00
4	Weiss & Wood, Evansville, Ind	3,985.00	1,992.50	3,983.00	1,992.50	3,985.00	15,948.00
5	J. E. & J. N. Abraham, Frankfort, Ky	4,000.00	2,000.00	4,000.00	2,000.00	4,000.00	16,000.00

The bid of J. Tom Williams & Bro., was accepted.

Abstract of bids received and opened April 19, 1889, by Maj. D. W. Lockwood, Corps of Engineers, for furnishing dimension stone at Lock No. 1, Barren River, and Lock No. 3, Green River, Kentucky.

No.	Name and address of bidder.	Lock No. 1, Barren River, 1302 cubic yards dimension stone.	Lock No. 3, Green River, 3152 cubic yards dimension stone.	Total.
		Per cubic yard.	*Per cubic yard.*	
1	Southern Construction and Quarry Company, Nashville, Tenn	$7.29	$7.92	$34,455.43
2	Willis & Co., Rochester, Ky	.....	7.70	24,270.40
3	I. V. Hoag, jr., Pittsburgh, Pa	10.00	10.00	44,540.00
4	Eigenmann & Hollerbach, Rockport, Ind. (or Green Castle stone)	7.95 6.25	6.24	30,019.38 8,137.50

The bid of Eigenmann & Hollerbach was accepted.

Abstract of bids received and opened May 23, 1889, by Maj. D. W. Lockwood, Corps of Engineers, for building snag-boat Wm. Preston Dixon.

No.	Name and address of bidder.	Total price bid.
1	James Ries, Pittsburgh, Pa	$22,750
2	Lambert Bros. & Co., Ironton, Ohio	18,900
3	M. A. Sweeney & Bro., Jeffersonville, Ind	18,400
4	Queen City Bridge and Steam Forging Co., Cincinnati, Ohio	21,835

The bid of M. A. Sweeney & Bro. was accepted.

REPORT OF LIEUTENANT WILLIAM L. SIBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Bowling Green, Ky., June 30, 1889.

SIR: I have the honor to submit the following report of operations on the Green and Barren rivers, Kentucky, for a portion of the fiscal year ending June 30, 1889:

The work on these rivers is carried on under the "Indefinite appropriation for operating and care of canals and other works of navigation."

The United States took possession of the locks and dams of these streams December 11, 1888.

From December until March no work except the operating and caring for the locks and dams was performed. During this time the tools and appliances necessary to carry out the work projected was purchased.

The condition of the locks and dams at present is about the same as represented in your report to the Chief of Engineers, December 15, 1888.

WORK DONE.

Lock No. 1, Green River.—Constructed a tool-house, cleared out the undergrowth, and removed some old buildings from Government land.

Lock No. 2, Green River.—Constructed a tool-house and built a fence around the lock-keeper's dwelling; built a crossing over mill-race, and cleared out the undergrowth from Government land.

Removed 2,500 cubic yards of dredged material from banks at upper entrance to lock. Dredged 4,500 cubic yards of material from upper entrance to lock, and wheeled same back to prevent its slipping into entrance again. Dredged 2,600 cubic yards of material from lower entrance to lock and wheeled same back.

Loaded three barges with sand for Lock No. 3, Green River.

Lock No. 3, Green River.—Constructed a tool-house, three derricks, 80 feet of trestle, 200 feet of tramway, and two tramway cars.

Removed 2,450 cubic yards of stone from fallen lock-wall and 250 cubic yards of stone and clay from crib below river wall of lock.

Loaded six barges with broken stone for Lock No. 2, Green River.

No work on removing fallen lock-wall has been done since May 27 on account of high water.

Transferred to tug *Mattie* from below the fallen lock to the pool above.

Lock No. 4, Green River.—Made extensive repairs to lock-keeper's dwelling, virtually rebuilding the house with the exception of the stone walls. Constructed a tool-house.

Lock No. 1, Barren River.—Constructed a tool-house and fenced in the Government property. Removed 2,500 cubic yards of material from behind land wall of locks.

GENERAL WORK.

Built two decked stone barges and two derrick boats.

Built new hull for dredge-boat; the machinery, cabin, etc., has not yet been transferred to new hull.

I wish to call especial attention to the condition of Lock No. 2, Green River. This lock is practically beyond repair, the foundation of both walls being in such bad condition that to repair them would be very expensive, and if repaired the lock would still have a bad location and a very poor quality of stone. The present location necessitates an annual expenditure of about $4,000 in dredging.

The dam is located at the head of a long rock shoal, and when all loose material is dredged from the lower entrance, there is scarcely 3 feet of water in the summer season.

To obtain the draught of water necessary to an economical shipment of coal, it would be necessary to blast out a channel between 200 and 300 yards in length below the lock.

In view of the bad condition of the lock, together with its faulty location, I would recommend that no extensive repairs be made, but that action be taken as soon as possible toward rebuilding and relocating the lock, trusting that it will stand in its present condition and answer the needs of navigation until the completion of a new lock.

Very respectfully, your obedient servant,

WM. L. SIBERT,
First Lieut. of Engineers.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S A.

Commercial statistics for fiscal year ending June 30, 1889.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
Beer.....cases and kegs..	2,354	$4,708	Lumber .... feet, B. M..	431,000	$7,752
Cooperage .....mt. bbls..	216	216	Merchandise.....tons..	15,000	3,750,000
Coal.....bushels..	1,506,436	150,643	Produce.....	.....	28,397
Cement.....barrels..	1,000	1,500	Posts.....number..	3,540	875
Flour.....do....	3,688	18,440	Roots.....pounds..	30	15
Grain.....bushels..	56,100	28,050	Salt.....barrels..	2,618	2,618
Hay.....tons..	628	10,048	Tobacco.....hhds..	3,000	300,000
Hides .....number..	873	3,492	Ties, railroad..number..	167,770	50,316
Handles .....do....	772,860	38,643	Logs .....feet, B. M..	82,950,000	1,244,250
Iron, manufactured..tons..	118	8,260	Whisky.....barrels..	306	30,600
Cattle .....head..	153	3,825	Passengers....number..	10,548	21,096
Hogs.....do....	2,150	21,500			
Horses.....do....	60	9,000	Grand total.....	.....	5,735,750
Jacks.....do....	3	1,500			

Report of lockages from December 11, 1888, to June 30, 1889.

Locks.	Days operated.	Days suspended.	Going up.			Going down.				Total craft and flats passing lock.	Total number of lockages.
			Steam-boats.	Barges and flats.	Miscellaneous.	Steam-boats.	Barges and flats.	Rafts.	Miscellaneous.		
Green River:											
No. 1.....	193	8	148	72	75	136	57	350	63	901	726
No. 2.....	197	4	142	57	13	130	50	300	2	694	569
No. 3.....	.....	201	.....	.....	.....	.....	.....	200	.....	200	.....
No. 4.....	199	2	58	25	27	57	24	41	24	256	344
Barren River:											
No. 1.....	201	.....	63	31	43	49	26	10	42	264	264
Total.....	.....	.....	411	185	158	372	157	901	131	2,315	1,903

G G 3.

IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

The Kentucky River is a tributary of the Ohio and empties into it at Carrollton, Ky., about midway between Cincinnati, Ohio, and Louisville, Ky.

The present project for the improvement of the river was adopted in 1879, the object being to repair the five locks and dams built by the State of Kentucky and extend slackwater navigation for a draught of 6 feet by the construction of additional locks and dams to Beattyville, a distance of 261 miles from the mouth of the river.

WORK DONE DURING THE YEAR.

Lock No. 6.—The site of this lock is 32 miles above Frankfort, Ky. The necessary land about the lock has been acquired by the United States, and the work of getting out stone is now in progress. At the commencement of the fiscal year a contract was in force with O'Brien & Co., who were to furnish the stone required. At this date they were very much behind in their work, having finished but little over one-third of the backing and but a small percentage of the other classes of stone. During the month of July their work did not improve, and

August 2, 1888, the contractors asked to be relieved from their contract, which request was refused by the Chief of Engineers, and the contract expired by its own terms August 31, 1888.

Proposals for furnishing the balance of the stone were at once asked for by public advertisement, and a contract was subsequently entered into with the Mason, Gooch & Hoge Company, at a considerable advance over the prices under the O'Brien & Co. contract.

The new contractors opened a quarry about 250 yards above the lock, but the quality of the stone proved to be below what was required for dressed face and special stones.

In May the contractors opened an additional quarry near Frankfort, where the same objections as to the quality of stone were found to exist.

Arrangements have now been made for obtaining the dressed face and special stones from Salem, Ind., and the stone so far furnished from that locality has proven of excellent quality, and as the capacity of the works is between 30 and 40 cubic yards per day, there will be no trouble on the part of the contractors in furnishing the stone required.

Up to the close of the fiscal year they had furnished the following:

	Cubic yards.
Special stone	23
Dressed face	375
Quarry face	380
Squared stone	401
Backing	946

As the balance of the appropriation for the Kentucky River will be required in carrying on work at Beattyville, no other work than that of obtaining stone will be undertaken at No. 6 during the fiscal year ending June 30, 1890.

Beattyville Lock.—During the year the work done toward building the lock has consisted in quarrying and cutting stone at Rock Shoal Quarry, 4 miles below Beattyville, and in preparing the site for the lock at Proctor.

The same reasons that located the passes of the old dam on the Proctor side of the river necessarily fix the location of the lock on the same side, and this has necessitated the removal of the old guide-walls of the passes as well as the Proctor abutment. Some idea of the amount of the material taken out of the old work can be obtained by reference to the accompanying report of Assistant Engineer R. S. Burnett.

The construction of this lock has been attended with many difficulties from the start. At times it has been very difficult to secure labor, and at all times the isolated location of the work, poor transportation facilities, and sickness during the hot season have operated against the work. The construction of the Kentucky Union Railroad to the crossing of the North Fork will be of great advantage to the Government work at this locality, as it will enable freight to be sent by rail to within 6 miles of Beattyville, instead of 80 miles as has been the case heretofore.

During the fiscal year ending June 30, 1889, the following work was done at Rock Shoal Quarry, to wit:

	Cubic yards.
Dimension stone quarried	10,419
Stone cutting:	
Dressed face stone	629.17
Special stone	375.22
Pitch or quarry face stone	1,097.12
Squared stone	837
Backing	3,646.26

In stripping and extending the quarry, 44,242 cubic yards of earth, 12,402 cubic yards of loose lock, and 8,831 cubic yards of solid rock were excavated.

At the site of the lock the work of tearing out the old passes and the Proctor abutment has progressed so far that the coffer dam is now being put in. The quarry is about 4 miles below the lock-site, and in order to transport the stone to it a pool will have to be formed by putting in a small dam near the quarry to back the water up to the lock.

It is hoped that the foundation of the lock can be put in this fall.

For details concerning the work done at Beattyville and the quarry, attention is invited to the report of Assistant Engineer Burnett herewith.

SNAG-BOAT KENTUCKY.

During the year the *Kentucky* was engaged almost exclusively in work on the lower river, in repairing locks and cribbing about the approaches, acting as tender to the dredge and derrick boat and removing snags. One hundred and two snags were removed from the channel.

In order to complete the two locks now in course of construction, with their dams and abutments, to wit, No. 6 and the one at Beattyville, and to commence work on Nos. 7 and 8 by securing the necessary land and contracting for stone for construction of same, an appropriation of $500,000 is respectfully recommended for the fiscal year ending June 30, 1891.

Money statement.

July 1, 1888, amount available		* $96,120.81
Amount appropriated by act of August 11, 1888		180,000.00
Received from Tabler & Cogar		500.00
		276,620.81
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$133,018.79	
July 1, 1889, outstanding liabilities	27,749.53	
July 1, 1889, amount covered by existing contracts	68,439.25	
		229,207.57
July 1, 1889, balance available		47,413.24
Amount (estimated) required for completion of existing project		1,854,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

* NOTE.—The change in amount available from that reported July 1, 1888, has been made owing to the reletting of work covered by amount reported last year as "covered by existing contracts."

Abstract of bids received and opened October 8, 1888, by Maj. D. W. Lockwood, Corps of Engineers, for furnishing stone for the construction of lock in the Kentucky River near Oregon, Kentucky.

No.	Name and address of bidder.	Cut stone.		Squared stone, 1,195 cubic yards.	Backing stone, 2,387 cubic yards.	Special, 252 cubic yards.	Coping, 276 cubic yards.	Aggregate.
		Dressed face, 1,686 cubic yards.	Quarry face, 1,209 cubic yards.					
		Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	
1	Mason, Gooch & Hoge Company	$14.00	$12.00	$8.50	$7.50	$22.50	$21.00	$87,238.00
2	Hoag & Petitdidier	16.45	15.00	11.00	7.31	21.00	21.00	96,961.67

The bid of Mason, Gooch & Hoge Company was accepted.

Abstract of bids received and opened January 3, 1889, by Maj. D. W. Lockwood, Corps of Engineers, for furnishing 5,000 barrels of cement for use in construction of lock in Kentucky River, at Beattyville, Ky.

No.	Name and address of bidder.	Natural cement on cars at Ford, Ky., for 5,000 barrels.	Natural cement on barges at Beattyville, Ky., for 5,000 barrels.	Aggregate.	Remarks.
		Per barrel.	*Per barrel.*		
1	Gilmer S. Adams, Louisville, Ky.	$1.21	No bid.....	$6,050	Diamond or star brands of Louisville, Ky., cement 265 pounds to barrel net.
2	S. M. Hamilton & Co., Baltimore, Md.	1.77	....do	8,850	Cumberland brand, 300 pounds net to barrel.

The bid of Gilmer S. Adams was accepted.

REPORT OF MR. R. S. BURNETT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., June 30, 1889.

MAJOR: I respectfully submit the following report on the improvement of the Kentucky River for the fiscal year ending June 30, 1889:

LOCK NO. 6.

O'Brien & Co., contractors for furnishing stone for Lock No. 6, continued work until the last of July, and then failed.

The following is a statement of the different classes of stone furnished by them during the fiscal year ending June 30, 1889:

	Cubic yards.
Dressed face stone	7.56
Quarry face stone	190.58
Squared	117.54
Backing	69.05

Mason, Gooch & Hoge Company, successful bidders for completing furnishing the stone for Lock No. 6, commenced work in February by opening a quarry about 259 yards above the site for the lock. In May they opened an additional quarry near Frankfort, for the purpose of getting out the dressed face stone. The stone was not found suitable for this class of stone, and only the other classes, with the exception of special stone, will be furnished from this quarry. As authorized by you, all dressed face and special stone will be quarried and furnished from their quarry at Salem, Ind.

The following is a statement of stone received from these contractors: Special, 23 cubic yards 10 inches; dressed face, 375 cubic yards 10 feet 12 inches; quarry face, 380 cubic yards 3 feet 21 inches; squared, 401 cubic yards 5 feet 31 inches; backing, 946 cubic yards 26 feet 52 inches.

Great difficulty has been experienced in obtaining a quarry where suitable stone could be found fulfilling the requirements of the specifications. The contractors are making every effort to complete their contract on time.

The United States property line was rerun by Mr. J. H. Westerfield, assistant engineer, and corner-stones set.

A platform was constructed 50 feet by 50 feet for marking out work and making templets for special stone.

BEATTYVILLE DAM.

The work of razeeing guide-walls was resumed early in September and suspended in January, and resumed again in May, preparatory to putting in the coffer-dam, for the purpose of excavating and putting in the foundation for the lock.

The following is a statement of material removed and work done:

Inside guide-wall.—Material removed from wall: Hewed oak timber, 9,700 linear feet; stone riprap, 2,859 cubic yards; deposit dirt and sand, 1,577 cubic yards; sheeting-oak, 30,936 feet, B. M.

Middle guide-wall.—Material removed from wall: Hewed oak timber, 16,722 linear feet; stone riprap, 4,517 cubic yards; deposit dirt and sand, 3,066 cubic yards; sheeting-oak, 51,736 feet, B. M.

Outside guide-wall.—Material removed from wall: Hewed oak timber, 14,290 linear feet; stone riprap, 1,660 cubic yards; deposit dirt and sand, 750 cubic yards; sheeting oak, 31,385 feet, B. M

Protection wall along the Proctor bank, below the "passes."—The wall is in good condition; a heavy deposit has been made behind it. It was raised 3 feet during the past season; the material used was taken from the guide-walls; stone excavated from the walls was deposited behind it.

Old material used in wall: 2,846 linear feet oak timber; 1,122 cubic yards riprap stone; 925 spikes, assorted.

General work.—Constructed one ice-house out of old material taken from the guide-walls; made and rigged two derricks for handling material; laid 4,000 feet, B. M., of sheeting on the dam; built blacksmith shop on the Proctor bank; constructed tramway from upper end of shore guide-wall to protection wall below; built trestling and bridge for tramway over ravine; built cement house on Beattyville side, 138 feet by 30 feet by 7 feet; constructed tramway from abutment to house; laid 14,000 linear feet of old oak timber for raising house above high-water line; built shed over hoisting engine; made 6 car-frames and 6 dump-boxes; removed 7,800 assorted spikes from oak timber; sharpened and straightened 7,800; removed 144 bolts, assorted; removed 327 wood-screws; built 1 pile-driver flat complete; built 2 out-houses and 1 carpenter shed; repaired office building; general carpenter work repairing tools; general blacksmithing work; storing cement.

Project for the fiscal year ending June 30, 1890.—Constructing coffer-dam for new lock; excavating to solid rock for foundation; putting in masonry foundation; constructing temporary dam at Rock Shoal for the purpose of pooling water to the site for new lock for the transportation of foundation and dimension stone.

NEW STONE LOCK.

Quarry at Rock Shoal.—Work was continued, quarrying and cutting stone, until latter part of November, when it was discovered that the stone freshly quarried and full of sap was being cracked by frost. Cutting stone was suspended until middle of April. It was found necessary to extend quarry, and the work of stripping the extension was carried on throughout the winter. Considerable trouble was experienced in preventing the hill-side slipping. Several large slides occurred, increasing the cost of stripping. The bank above the quarry was shored with heavy timber bolted to the rock along the whole length of the quarry. The work at this quarry has cost fully 20 per cent. more than it would in a more accessible place. All mechanics, stone-cutters, and laborers have to be paid high wages in order to retain a working force; and from its isolation and lack of direct communication with railroads the transportation of material is costly.

The following is a detailed statement of work done:

Dimension stone quarried: 10,414 cubic yards.

Dressed stone: Dressed face, 929 cubic yards, 17 feet; special stone, 375 cubic yards, 22 feet; pitch face, 1,097 cubic yards, 12 feet; squared, 837 cubic yards; backing, 3,646 cubic yards, 26 feet.

Material excavated and removed in stripping and extending quarry: Earth, 44,243 cubic yards; loose rock, 12,402 cubic yards; solid rock, 8,831 cubic yards.

Carpenter work.—Built two carpenters' sheds, one pattern-house.

Stripped: Three quarter-houses, pattern-house, office, store-house, blacksmith shop; enlarged blacksmith shop; built sheds over two engines; dressed and made four derricks complete; repaired booms and masts of five derricks; made seven derrick-seats and frames; cut, dressed, and placed two hundred and thirty railroad ties; laid floor, 50 feet by 50 feet, for laying out lock and making templets for special stone.

Made the following articles: 179 straight-edges, 457 handles for tools, 7 dump-boxes, 12 car-frames, 10 boxings for stone cars, 12 cavils, 6 frames for deadmen, 4 snatch-locks, 3 ladders, 22 rollers, 4 pike-poles, 2 draughting-boards, 3 coal-boxes, 3 tool-boxes, 6 benches, 2 desks, 6 guy-fastenings, 8 doors, 4 pairs steps, 10 trestles, 20 awning-frames.

Repaired and dressed 128 straight-edges. Calked and repaired skiffs and freight-boat, and did general repair work.

General work.—Excavated 180 cubic yards of material for platform for laying out lock and making templets; repairing, changing, and extending railroad track; clearing cutting-yard of quarry chips; rigging, setting up, and moving derricks; removed 470 cubic yards of material extending track; laid 200 linear feet of timber for track; built trestling for track; moved the following buildings: office, two engine sheds, water-tank, out-house, 1 pump for railroad; laid 620 linear feet of track; shoring up bank behind quarry; laid 1,125 linear feet of timber in this work; made

ditches around all buildings; hauling stone from quarry to cutting-yard and slacking cut stone; hauling water for use of employés one-half mile.

Project for the fiscal year ending June 30, 1890.—Completing quarrying and cutting stone.

Respectfully submitted.

R. S. BURNETT,
Assistant Engineer.

To Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Trade of the Upper Kentucky River, Kentucky, for fiscal year ending June 30, 1889.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
Brick .....number..	65,000	$520.00	Salt.....barrels..	2,650	$5,300.00
Beer..... cases..	360	720.00	Stone, rough..cubic yds..	1,500	1,500.00
Coal.....bushels..	42,000	5,880.00	Ties, railroad. number..	110,000	44,000.00
Cement.....barrels..	4,800	7,200.00	Logs:		
Flour..... do....	2,150	15,050.00	Assorted.....do....	36,400	109,200.00
Grain.....bushels..	8,500	5,100.00	Poplar ..... do....	96,200	288,860.00
Hay .....tons..	560	7,840.00	Oak.....do....	79,540	238,620.00
Hogs.....number..	446	2,676.00	Walnut.....do....	28,150	281,500.00
Hides.....do....	240	960.00	Staves ..... do....	125,350	3,133.75
Iron, manufact'd...tons..	153	11,475.00	Tobacco ....hogsheads..	110	11,000.00
Lumber:			Whisky.....barrels..	145	10,875.00
Oak .....feet, B. M..	236,000	4,248.00	Miscellaneous merchandise.....tons..	8,120	1,624,000.00
Poplar.....do....	365,000	5,840.00	Passengers ....number..	2,150	5,375.00
Walnut.....do....	85,000	5,100.00			
Produce.....	.....	10,600.00			
Roots.....pounds..	320	160.00	Total.....	.....	2,706,732.75

G G 4.

OPERATING AND KEEPING IN REPAIR THE FIVE LOCKS AND DAMS ON THE KENTUCKY RIVER, KENTUCKY.

The United States acquired possession of these locks and dams in 1880, at which date they were found to be in a sadly crippled condition; the dams being in an advanced stage of decay, while the gates and operating machinery of the locks were in such state as to need absolute removal or extensive repairs.

Most of the dams have been entirely rebuilt, the others nearly so. Guide-walls, above and below the locks, have been constructed and the banks about locks and abutments protected by timber-cribbing, where necessary to prevent them from erosion.

At present there is good slackwater navigation to Oregon, 99 miles from the Ohio River.

The work of the past year has been carried on with a view to establishing the security of the locks, dams, and accessories, and that projected for the fiscal year ending June 30, 1890, has the same object in view.

It had been expected that the allotment of last year would be sufficient to complete the extensive repairs at the different locks, but it was found that the projected work at No. 1 would have to be extended to obtain the object sought, and the giving way of some of the arms indicated that new gates were necessary, while at No. 2 high water prevented the construction of the new abutment as intended.

Part of the old plant requires complete removal, to wit: The dredges,

two dump-scows, and the derrick-boat. These have become so badly decayed and worn out as not to be worth repairing.

During the past year 13,883 cubic yards of material were removed from about the lock entrances. Some dredging is required after every high water, and while the quantity of material in each instance may be small, its removal is absolutely necessary to insure the full capacity of the navigation.

Wherever slide-valves have been put in to replace the old butterfly valves, the leakage has been much less than before and the improvement marked.

It is proposed to apply the allotment for the fiscal year ending June 30, 1890, as follows:

Lock No. 1.—Rebuilding lower river guide-wall. Constructing lower lock-gates. Repairing steps to dam. Putting in slide-valves in upper gates. Dredging entrances when necessary.

Lock No. 2.—Constructing stone abutment. Putting slide-valves in upper gates. Building double dwelling for keeper. Repairing step-sheeting to dam. Dredging entrances when necessary.

Lock No. 3.—Constructing one single keeper's dwelling. Repairing lock-wall. Grading around dwellings, making brick walks. Dredging entrances when necessary.

Lock No. 4.—Repairing step-sheeting of dam. Placing new operating irons on upper and lower gates. Dredging entrances to lock and the Leestown and Clifton bars.

Lock No. 5.—New single dwelling for keeper. Complete leveling of dam. Complete grading and paving bank. Dredging when necessary.

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, improved by locks and dams during the fiscal year ending June 30, 1889.

Months.	Lock No. 1.					Lock No. 2.				
	Salaries.	Labor and material.	Dredging.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Dredging.	Current and contingent expenses.	Total.
1888.										
July	$302.80	$9.00	$142.53	$10.98	$465.31	$302.80	$193.31	$142.53	$3.73	$642.37
Aug	162.35	705.39	122.50	4.40	994.62	162.33	1,086.60	.....	4.40	1,253.33
Sept	323.90	431.20	.....	12.98	768.08	323.90	888.45	.....	17.22	1,229.57
Oct	252.80	1,502.55	.....	13.85	1,769.20	165.00	2,397.59	.....	6.75	2,569.34
Nov	261.20	7,876.06	199.50	15.88	8,352.64	261.20	196.69	.....	5.38	463.27
Dec	165.00	2,389.53	.....	16.20	2,570.73	165.00	660.12	.....	8.95	834.07
1889.										
Jan	228.23	351.45	19.00	14.87	613.55	238.73	945.86	19.00	14.88	1,218.47
Feb	165.00	43.80	.....	14.40	223.20	165.00	976.25	14.50	.....	1,155.75
Mar	198.00	10.54	.....	5.32	213.86	198.00	1,528.95	.....	2.07	1,729.02
Apr	165.00	.....	18.00	2.15	185.15	165.00	798.28	.....	1.80	965.08
May	231.20	.....	134.30	.....	365.50	230.21	154.00	.....	.....	384.21
June	159.00	455.89	18.00	2.00	734.89	159.00	21.00	18.00	1.00	199.00
Totals	2,614.46	13,875.41	653.83	113.03	17,256.73	2,536.17	9,847.10	194.03	66.18	12,643.48

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, etc.—Continued.

Months.	Lock No. 3.					Lock No. 4.				
	Salaries.	Labor and material.	Dredging.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Dredging.	Current and contingent expenses.	Total.
1888.										
July	$303.07	$139.30	$5.86	$3.73	$451.96	$302.80	$472.32	$5.86	$25.01	$805.99
Aug	162.34	1,192.93	.....	21.78	1,377.05	162.34	2,157.63	.....	124.72	2,444.69
Sept	323.90	1,475.55	.....	16.74	1,816.19	323.90	2,148.74	.....	10.74	2,483.38
Oct	180.50	2,217.81	.....	32.25	2,430.56	215.00	4,814.05	.....	10.50	5,039.55
Nov	261.20	1,411.40	.....	7.48	1,680.08	170.95	2,188.91	.....	80.38	2,440.24
Dec	220.00	813.47	145.00	22.21	1,200.68	220.00	3,303.83	.....	13.86	3,537.69
1889.										
Jan	293.73	1,464.04	19.00	11.25	1,788.02	293.73	1,627.82	19.00	15.20	1,955.75
Feb	184.33	.....	14.50	.....	198.83	184.33	9.60	14.50	.80	209.23
Mar	198.00	73.92	.....	2.07	273.99	198.00	170.16	.....	18.21	386.37
Apr	165.65	62.36	18.00	1.80	247.81	165.00	24.60	18.00	406.00	613.00
May	231.20	97.80	.....	.....	329.00	231.20	.....	.....	14.80	246.00
June	159.00	57.91	18.00	1.00	235.91	159.00	55.61	18.00	15.16	247.77
Totals	2,682.92	9,006.49	220.36	120.31	12,030.08	2,626.25	16,972.66	75.36	735.38	20,409.66

Months.	Lock No. 5.					U. S. snag-boat Kentucky.			
	Salaries.	Labor and material.	Dredging.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1888.									
July	$302.80	$7.66	$5.86	$3.74	$320.06	$695.00	$1,047.14	$4.90	$1,747.04
Aug	162.33	17.98	122.50	24.31	327.12	872.16	140.46	.....	1,012.62
Sept	323.90	269.70	290.00	8.74	892.34	841.50	131.55	.....	973.05
Oct	215.00	777.62	261.66	12.71	1,266.99	875.50	220.14	.....	1,095.64
Nov	261.20	1,111.75	.....	16.35	1,389.30	869.50	33.15	.....	902.65
Dec	220.00	666.70	145.00	18.41	1,050.11	842.00	290.86	.....	1,132.86
1889.									
Jan	293.74	1,466.64	19.00	14.97	1,794.28	1,004.50	41.65	.....	1,046.15
Feb	184.34	.....	14.50	.....	198.84	782.50	31.50	.....	814.00
Mar	198.00	.....	.....	17.60	215.60	563.32	190.62	.....	753.94
Apr	165.05	57.54	18.00	1.80	242.34	455.00	142.71	.....	597.71
May	231.20	173.61	.....	.....	404.81	455.00	.....	.....	455.00
June	159.00	26.26	18.90	4.00	207.26	495.00	28.70	.....	523.70
Totals	2,716.51	4,575.46	894.52	122.56	8,309.05	8,750.98	2,298.48	4.90	11,054.36

RECAPITULATION.

Lock No. 1	$17,256.73
Lock No. 2	12,643.48
Lock No. 3	12,030.08
Lock No. 4	20,409.66
Lock No. 5	8,309.05
Snag-boat *Kentucky*	11,054.36
Total incurred	81,703.36

Abstract of bids received and opened September 20, 1888, by Maj. D. W. Lockwood, Corps of Engineers, for furnishing materials and labor for constructing keepers' dwellings at Locks Nos. 3, 4, and 5, Kentucky River, Kentucky.

No.	Name and address of bidder.	Lock No. 3, one house.	Lock No. 4, one house.	Lock No. 5, one house.	Aggregate.
1	Choate & Brawner, Frankfort, Ky	$2,041.10	$2,041.10	$2,041.10	$6,123.30

The bid of Choate & Brawner was accepted.

REPORT OF MR. R. S. BURNETT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., June 30, 1889.

MAJOR: I respectfully submit the following report on the operating and care of canals and the maintaining and preserving of navigation on the Kentucky River for the fiscal year ending June 30, 1889:

Part of the work projected for last year could not be completed on account of an unusual stage of water, the work requiring very low water. The lower river guide-wall at Lock No. 1 and the leveling of dam at No. 5 are the works not completed. Where grading and paving were done at the several locks, it was found necessary to do much more than was contemplated. The stone used in making repairs was quarried by hired labor in the vicinity of the locks. All the other material was purchased by contract, and all construction done by hired labor, with the exception of new dwellings for lock-keepers.

Numerous small rises have occurred during the year, but no extreme high rises. The pools have been full, there not being less than 6 feet of water on the lower miter-sill at any of the locks throughout the year.

All works constructed and repairs made have stood well, and no damage has been done at any point.

One coal-barge was sunk in the entrance of Lock No. 3, caused by several planks being knocked off her bottom while being pushed over some drift; and one small steam-boat was sunk at the mouth of the river while tied to the bank.

No steps have been taken by corporations controlling bridges obstructing navigation to make the necessary alterations.

A new dredging plant is needed badly. The dredge transferred to this river from the Louisville and Portland Canal—where it had been condemned some years ago—is in very bad condition. The hull could not be repaired to advantage, as timbers are all rotten and it is with difficulty that it is kept afloat. The dump-scows are in as bad condition.

The following is a detailed statement of the work done during the past year:

LOCK NO. 1.

Paving bank between lock-wall and turnpike.—One thousand three hundred and ninety-six square yards of paving laid; 331 cubic yards of sand placed on paving.

Lower shore guide-wall.—The old wall was removed to an elevation of 6 feet above the lower miter-sill; 2,678 linear feet of old timber were removed, and 1,256 cubic yards of stone and dirt.

In reconstructing the wall it was found necessary to extend it further down the river, making a return to the top of the bank, to make the entrance safer. Boats were damaged and delayed on account of the strong reaction of the water at certain stages of the river. The wall was constructed 410 feet in length; material expended, 31,898 linear feet of hewed white oak timber; 5,499 cubic yards of riprap-stone filling; 12,560 pounds of spikes.

Lower river guide-wall.—This wall was not constructed as contemplated, on account of the continuous high-water stage of the Ohio River. Removed 5,400 linear feet of old oak timber and 1,063 cubic yards of stone.

Upper shore guide-wall.—The upper end of this wall was raised 5 feet. Material expended, 250 linear feet of timber, 150 cubic yards of stone, 200 pounds of spikes, Ten thousand, three hundred and nine cubic yards of clay and gravel filling were placed behind the wall

Upper river guide-wall.—Sheeted the inside face of wall with 3-inch oak lumber. Material expended, 1,285 feet, B. M.

Abutment and extensions.—Placed 67 cubic yards of clay along upper extension to stop small leaks under it; cut and placed 125 cords of willows behind lower extension to aid in collecting sediment; removed 500 cubic yards of stone from front cribs to rear ones to aid uniform settlement.

Lock-walls.—Dressed the entire top of river wall where coping was defective, and filled in with Portland cement all defective places; 403 square yards of cement placed. Removed 5 cubic yards of old coping and reset 5 cubic yards of new. Pointed entire wall, except inside face.

Fencing.—Constructed 1,182 linear feet of new fence around United States property. Built stone masonry wall from lower end of lock-wall back 85 feet; laid 32 cubic yards of masonry.

General work.—Graded bank above turnpike; removed 10,309 cubic yards of material. Made ditch above pike the entire length of pike, through United States property. Repaired lower lock-gates by bolting straps on five arms which were cracked by water-pressure. Made one wooden capstan for lower gates. Repaired all operating irons. Repaired tool-house and tools. Regraded pike from office to bridge above the lock, and placed 45 cubic yards of broken stone on the same. Built office-building above the turnpike. Made fill between lower end of lock-wall and pike; placed 142 cubic yards of material. Made steps from lock-wall to the pike. Made walks around lock-house. Painted lock-gates. Calked skiffs.

Dredging.—Removed from upper and lower entrance 2,456 cubic yards of material.

There was no suspension of navigation at this lock from any cause during the year. Highest water occurred November 10, lower gauge reading 36 feet. The Ohio River kept up almost continuously during the year. The lowest water occurred August 12, lower gauge reading 6.10 feet.

LOCK NO. 2.

New abutment.—Continuous high water prevented the construction of this abutment this season. All the material was purchased and the necessary stone quarried and cut at quarry on Government land at Lock No. 6.

Quarried 273 cubic yards of dimension stone; cut 653 cubic yards of dimension pitch-face stone and 15 cubic yards of coping.

Quarry.—At the quarry above lock on United States property there were quarried 4,534 cubic yards of riprap stone; 1,978 cubic yards of material were removed in stripping the quarry (the object in quarrying stone at this point was to obtain a site for a new lock-keeper's dwelling, as well as to obtain the riprap stone used at the several locks in the most economical manner); 27.5 cubic yards of dimension stone were cut; also 49 step-stones. All stone quarried was used at Locks Nos. 1, 2, and 3.

Lock-walls.—Ten cubic yards of defective coping-stone were removed and replaced with new. Other defective coping was dressed and filled with Portland cement, and wall pointed.

The retaining-wall at upper end of lock-wall was repaired; 9 cubic yards of masonry laid, and three steps placed.

Paving.—Two hundred and ten square yards of paving laid; 60 cubic yards of sand placed on paving.

Dam.—Step-sheeting was respiked, and 8 defective pieces removed and replaced with new timber.

General work.—Painting lock-gates, repairing operating irons, removing drift from entrance, repairing tools and tool-house.

Dredging.—Removed 1,309 cubic yards of material from entrances and lock-pit.

There was no suspension of navigation from any cause at this lock during the year. The lowest gauge-reading occurred August 17; lower guage reading 6.20 feet, upper 7.60 feet. Highest water occurred September 4; lower gauge reading 23.20 feet, upper 14.30 feet.

LOCK NO. 3.

Raising and extending the abutment below the dam.—To prevent further caving of the bank, endangering the abutment, a return-wing was constructed from lower end of old extension to the top of the bank and the old work raised 6 feet.

Material expended on this work as follows: 5,248 lineal feet hewed white oak timber, 782 cubic yards of riprap stone, 2,950 pounds of spikes.

Paving and grading bank behind lock-wall.—Removed old grist-mill from slope; removed 658 cubic yards of old paving-stone; removed 3,761 cubic yards of earth; removed 15 large trees.

This material was all utilized in filling between lower shore guide-wall and old lock-house, between upper shore wall and tool-house, and between top of bank behind lock-wall and new lock-house.

Stone steps were laid from lock-wall to top of the bank; 33 stones were dressed and laid in this work. One thousand one hundred and forty-two square yards of

paving laid; 492 lineal feet of curbing-stone dressed and laid at edge of paving on grade and along the sides of steps.

Lock-keeper's dwelling.—One single dwelling was constructed by contract.

Repairing lock-gates.—A coffer-dam was constructed across upper entrance; 145 cubic yards of deposit was removed from around gates; four old filling valves were taken out of gates and new slide-valves put in, together with entire new set of operating irons.

Fencing.—The old fence around United States property was removed and a new one built.

General work.—Three hundred and six square yards of sod was placed on bank above the paving, to prevent its washing; 52 cubic yards of stone masonry laid on slope wall, extending from upper end of lock-wall to top of the bank; 171 cubic yards of sand was placed on the paving. Removed 75 cubic yards of loose stone from lower entrance to lock. Laid oak floor in cellar of new lock-house. Raised tool-house 2 feet above the ground; shingled and whitewashed it. Painted lock gates. Repaired operating irons. Removed drift from entrance.

Dredging.—Removed 1,749 cubic yards from entrances.

Navigation was suspended at this lock four days, December 9th to 13th, caused by a loaded coal-barge sunk in upper entrance. While this was being raised the upper entrance was coffer-dammed and the new slide-valves put in gates.

Highest water occurred November 30; upper gauge reading 15.40 feet, lower 24 feet. Lowest water occurred August 13; lower gauge reading 6.40 feet, upper 8.30 feet.

LOCK NO. 4.

Lower shore guide-wall.—Most of the stone taken out of the old slope wall was used in paving bank behind lock-wall and building masonry grade-walls at each end of the lock.

The following material was removed: 1,110 cubic yards of stone; 483 cubic yards of earth; 300 cubic yards of old cribbing from the lower end.

The wall was reconstructed to within 18 inches of the top of lock-wall of oak timber and stone.

The following material was used in its construction: 19,960 linear feet of hewed white-oak timber; 3,034 cubic yards of riprap stone; 24,899 pounds of spikes. Total length of wall, 321 feet. The top of the wall was paved with stone.

Grading and paving bank behind lock-wall.—All old paving was taken out and the bank graded from the lock-wall to top of the bank to a uniform slope of 4 to 1.

At each end of the lock-wall masonry grade walls were built, they also extending to the top of the bank.

The paving was extended up to average high-water line, and from that line to top of bank sod was laid.

The following is a statement of material removed: 360 cubic yards of paving stone, 540 cubic yards of earth, 6 large sycamore trees.

The following material was used in repairing and grading bank: 210 cubic yards of earth used in filling sunken places; 656 cubic yards of stone; 645 cubic yards of stone masonry were used in building grade walls.

Stone steps were laid from lock-wall to top of bank; 35 stones were quarried and dressed and placed; 1,555 square yards of sod were laid from paving to top of the bank; 245 cubic yards of sand placed on paving.

Lock-walls.—All defective coping-stone was dressed out and Portland cement filling put in; 23 cubic yards of coping taken out and replaced by new stone; recut and repainted water-gauges.

Upper shore guide-wall.—The stone in the cribbing was leveled off and the entire length of wall paved; the land behind this wall was uniformly graded and sodded; 1,850 cubic yards of earth removed; 980 square yards of sod laid; a drain was dug from ice-house, 265 feet in length, down ravine, and emptying through upper shore-wall into the river; 36 cubic yards of stone were used paving it; 16 cubic yards of masonry work laid carrying it under roadway, and 30 linear feet of 20-inch tiling used in carrying it through river-wall.

Upper gates.—The upper entrance was coffer-dammed and four old valves taken out of gates and replaced by new slide-valves and operating irons.

Buildings.—One single lock-keeper's dwelling built by contract, 1 tool-house, 1 ice-house, 1 out-house, 1 coal-house; built back porch to new dwelling.

Fencing.—Two thousand four hundred and forty-eight linear feet of fence constructed around United States property; 4 gates built in fence.

General work.—Quarry opened opposite the lock for the purpose of furnishing the necessary stone to be used in making repairs; 3,150 cubic yards of stone were quarried; 725 linear feet of brick wall 4 feet wide laid around dwellings; 140 linear feet of walk made with broken stone and saw-dust. Made and rigged 2 derricks used in

constructing lower shore guide-wall. Made and rigged 1 derrick complete, for the derrick-boat. Made steps for back porch to new dwelling. Laid oak floor in the cellar of new dwelling. Repaired fence on river bank. Planted 35 water-maple trees around walks. Whitewashed out-buildings and fence. Painted lock-gates and part of tool-house. Repaired derrick-boat, pile-driver, stone dump-boxes; built 3 new dump-boxes. Leveled and graded land around lock-keepers' dwellings and sowed grass seed. Repaired operating irons. Took down old lock-keeper's dwelling, also three old out-buildings. Repaired cistern and put in new pump. General repairs to tools and machinery.

Dredging.—Removed from point immediately below lower entrance 3,450 cubic yards of material; from gravel-bar 1 mile below lock, 2,890 cubic yards; from entrance and lock-pit, 915 cubic yards.

There was a suspension of navigation three days, from December 9 to 12, while upper entrance was coffer-dammed for the purpose of putting in new slide-valves in gates.

Highest water occurred February 21, lower gauge reading 23.00 feet, upper 12.50 feet. Lowest water occurred August 3, lower gauge reading 6.05 feet, upper 6.20 feet.

LOCK NO. 5.

Leveling dam.—Continuous high-water stage of the river prevented drawing down the pool sufficient to complete this work. The following work was done: 80 linear feet of 8-inch by 6-inch white-oak lumber was laid on crest in leveling up, and 70 pieces 6 feet by 12-inch by 3-inch oak sheeting were spiked on slope.

Paving and grading bank behind lock-wall.—The new paving was carried up the bank to average high-water line; 205 cubic yards of paving-stone were taken out; removed 1,160 cubic yards of earth; laid 654 square yards new paving; placed 323 cubic yards sand on paving; built stone steps from lock-wall to top of bank; laid 480 linear feet of curbing at end of paving and at the sides of steps; built grade-wall at lower end of lock to top of the bank; 180 cubic yards of stone laid.

New single lock-keeper's dwelling.—One new dwelling completed by contract.

General work.—Quarry: Quarry was opened near lock to obtain necessary stone in making repairs; quarried and dressed 15 cubic yards of stone for steps, 210 cubic yards for paving, and 46 cubic yards for curbing-stone; cut down and removed 8 trees from grade; tore down old tool-house and blacksmith shop for site for new dwelling; filled large sink-hole immediately behind lock-wall with clay and stone, well rammed; rigged derrick and built tramway from old quarry on the hill to lower end of lock-wall; pointed lock-wall; painted gates; rigged traveler from upper end of river wall to upper guide-pier for carrying light; built one out-house; dredged upper and lower entrance, also the lock-pit; removed 1,395 cubic yards of material.

There was no suspension of navigation at this lock.

Dredging: 1,114 cubic yards of material were removed from entrances and lock pit.

The highest water occurred February 20; upper gauge reading 14.50 feet, lower 22.20 feet. Lowest water occurred August 15; upper gauge reading 8.2, lower, 6 3.

UNITED STATES DREDGE.

The dredge has done general dredging as follows:

Removed material from lock entrances:	Cubic yards.
Lock No. 1	2,456
Lock No. 2	1,309
Lock No. 3	1,749
Lock No. 4	7,255
Lock No. 5	1,114

UNITED STATES SNAG-BOAT KENTUCKY.

The boat has been employed in towing stone used in making repairs to the several locks and hoisting the same into the cribbing; hoisting timber at Locks Nos. 1 and 3; constructing coffer-dam at Lock No. 3; acting as tender to United States dredge; towing derrick-boat; general snagging work on the river.

The steamer was hauled out on marine ways at Cincinnati and calked. Removed 102 snags from channel. Wrecked one barge and one steam-boat at the mouth of the river. Days laid up, 89. Total miles run, 3,570.

UNITED STATES DERRICK-BOAT.

The boat has been used at Locks No. 3 and 4 in making repairs, hoisting timber and stone; and at Lock No. 6, handling new stone for the abutment at Lock No. 2.

The boat is worthless and can not be repaired.

STONE BARGES.

Barges were taken out at Lock No. 1 and calked. They are in bad condition and not worth repairing. They were used in the transportation of material for making repairs at the several locks.

Respectfully submitted.

R. S. BURNETT,
Assistant Engineer.

To Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Trade of Lower Kentucky River, Kentucky, for fiscal year ending June 30, 1889.

Articles.	Quantities.	Value.	Articles.	Quantities.	Value.
Beer.....cases..	649	$1,298.00	Lumber, walnut, feet B. M.....	165,000	$8,900.00
Brick.....number..	535,000	3,745.00	Produce.....	.....	42,565.00
Coal.....bushels..	2,082,260	312,339.00	Roots, assorted..pounds.	650	260.00
Chairs.....number..	1,285	2,077.50	Salt.....barrels..	8,851	8,851.00
Cement.....barrels..	2,445	3,667.50	Stone:		
Cooperage:			Dressed...cu. yds..	1,080	10,800.00
Barrels....number..	18,849	28,273.50	Rough.....do..	2,150	2,687.50
Hogsheads....do....	5,280	13,200.00	Ties, railroad..number.	22,335	26,934.00
Staves.....do....	185,000,000	46,250.00	Timber.....lineal feet.	102,000	18,360.00
Flour.....barrels..	20,257	101,285.00	Assorted logs..number.	138,965	694,825.00
Grain.....bushels..	746,382	447,829.20	Walnut logs.....do..	7,558	113,370.00
Hay.....tons..	5,375	75,250.00	Tobacco....hogsheads.	6,980	698,000.00
Hemp.....do....	34	4,250.00	Whisky.....barrels..	31,779	2,860,110.00
Hides.....number..	2,302	9,208.00	Wood.....cords..	404	1,212.00
Iron, manufactured, tons	3,244	227,080.00	Miscellaneous merchandise.....tons..	16,872	4,218,000.00
Junk.....do....	570	11,400.00	Passengers...number..	24,721	37,081.00
Cattle.....number..	2,453	98,120.00			
Hogs.....do....	6,096	48,768.00	Total.....	.....	10,368,766.22
Horses.....do....	573	57,300.00			
Sheep.....do....	3,600	12,600.00			
Lumber, assorted, feet B. M.....	6,211,779	111,812.02			

Report of lockages for fiscal year ending June 30, 1889.

Locks.	Days operated.	Days suspended.	Going up.			Going down.				Total craft and flats passing lock.	Total number of lockages.
			Steam-boats.	Barges and flats.	Miscellaneous.	Steam-boats.	Barges and flats.	Rafts.	Miscellaneous.		
No. 1.....	365	....	560	217	42	566	202	53	41	1,683	1,514
No. 2.....	365	....	557	151	187	558	148	204	41	1,846	1,710
No. 3.....	361	4	467	158	64	466	143	78	35	1,411	1,369
No. 4.....	362	3	478	190	58	464	179	78	3	1,450	1,374
No. 5.....	365	....	258	233	141	264	225	2,041	123	3,285	2,263
Total.....	.....	....	2,320	949	492	2,320	897	2,454	243	9,675	8,230

Total increase of lockages over fiscal year ending June 30, 1888, 2,639.

G G 5.

IMPROVEMENT OF LICKING RIVER, KENTUCKY, FROM FARMERS TO WEST LIBERTY.

The project for the improvement of this river was approved by the Secretary of War, under date of September 20, 1888, and contemplates the removal of snags, detached rocks and bowlders from the river bed, with a view to improving low-water navigation.

During the season of 1888 the water was too high for effective work, and in consequence nothing was done.

In May of this year a plant suitable for work at low water was made ready, and after doing some work in the vicinity of Farmers was moved to West Liberty to work down-stream.

Up to June 30, 1889, the following work had been done: Twenty-five trees, averaging 61 feet in length; 57 snags, averaging 20 feet in length, and 76 snags have been removed.

This improvement is not a permanent one, as the obstructions caused by trees, snags, and stumps are liable to reform each year.

The original estimated cost of the work was $260 per mile, or $17,680 for that portion of the river between Farmers and West Liberty, and it is recommended that of this amount $10,000 be appropriated for the fiscal year ending June 30, 1891.

Money statement.

Amount appropriated by act of August 11, 1888		$3,000.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$392.26	
July 1, 1889, outstanding liabilities	400.25	
		792.51
July 1, 1889, balance available		2,207.49
Amount (estimated) required for completion of existing project		14,680.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		10,000.00
Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.		

G G 6.

IMPROVEMENT OF THE BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The Big Sandy River, which is formed by the union of the Tug and Levisa forks at Louisa, flows north a distance of 26 miles and empties into the Ohio at Catlettsburgh, Ky. The main river and the Tug (or eastern) Fork from the boundary line between West Virginia and Kentucky, and the upper part of the Tug for a distance of about 18 miles, forms the boundary between Virginia and West Virginia. The Tug Fork rises in the southwest corner of West Virginia, and flows northwest to its junction with the Levisa Fork, with a total length of about 140 miles. The Levisa (or Louisa) Fork rises in the southwestern part of Virginia, whence it enters Kentucky, and flows in a northerly direction. Its total length is about 189 miles. The total length of the Big Sandy River is therefore 215 miles.

The present approved project for the improvement of this river contemplates the construction of a lock and dam at Louisa, below the junction of the two forks, and also the improvement of open-river navigation on these forks and on the main river. The object of building the dam is to form a pool for holding coal-boats and barges, with a view to the shipment of coal from the extensive deposits found in the valley. It is expected that other locks and dams will be built if this preliminary one should prove a success. For open-river navigation on the forks it is intended to secure a channel with a minimum depth of 1 foot and a minimum width of 50 feet during six months in the year. At present the forks are chiefly used for rafting, but there is occasional navigation as far as Piketon and Warfield by light-draught steam-boats, and a large amount of material is poled up the river in push-boats. The country is mountainous, the roads are few in number and in poor condition, and the river is the chief reliance for obtaining such articles as can not be grown or manufactured in the country.

It is recommended that an annual appropriation of $2,500 be made for each fork, with a view to keeping them clear of snags and other obstructions.

During the year the lower river has been cleared of snags and other obstructions to navigation. The lock-gates and wickets for the lock at Louisa are so far advanced that their completion in place is assured by July 15.

The dam and approaches can be completed in one favorable working season, and with the amount estimated for completion of project. It is respectfully recommended that this amount, $31,145.31, be appropriated for the fiscal year ending June 30, 1891.

In order to carry slackwater navigation from the Ohio to Louisa two additional locks and dams will be required. Their cost will be the same as that of the one already built, to wit, $213,237.39, for each one.

The advantages to be derived from continuing slackwater navigation above the lock already built are evidently greater than those to be obtained by continuing the system from the present lock to the Ohio, for when the proper pools are once formed reaching to the coal-fields, coal-barges can be loaded and wait in the Louisa pool for sufficient water below the Louisa lock to take them into the Ohio. I therefore recommend that $100,000 be appropriated for the fiscal year ending June 30, 1891, to commence the construction of an additional lock on the Louisa Fork. This is to be in addition to the $31,145.31 asked for the completion of the dam and the approaches to the lock at Louisa.

For details connected with the work of the past season, attention is invited to the report of Assistant Engineer B. F. Thomas herewith.

Money statement.

July 1, 1888, amount available		$3,462.38
Amount appropriated by act of August 11, 1888		31,500.00
		34,962.38
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$10,999.26	
July 1, 1889, outstanding liabilities	762.10	
		11,761.36
July 1, 1889, balance available		23,201.02
Amount (estimated) required for completion of existing project		31,145.31
Amount that can be profitably expended in fiscal year ending June 30, 1891		131,145.31
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

PARKERSBURGH, W. VA., *June* 30, 1889.

MAJOR: I have the honor to submit my report for the year ending June 30, 1889, for the Big Sandy River.

The present project contemplates the building of a lock and dam just below the junction of the Levisa and Tug forks, at a point about 26 miles from the mouth of the Big Sandy at Catlettsburgh. Two other dams will be required below this to make good navigation the year round. The present work when finished will throw a pool some 12 miles long in Louisa and about 7 miles long in Tug, along which are found excellent coal beds which only await transportation facilities to be developed.

A little higher up-stream fine cannel coal has been discovered, and a few more locks and dams in this direction will cause the development of a field of mineral of vast importance to all the Ohio and Mississippi valleys.

The masonry of the lock and abutment is completed, and the lock gates and wickets are now being put in place and will be done by the middle of July. The upper approach to the lock was excavated previous to my last report, and the lower approach was worked upon last season. Like the upper, it is a ledge of solid rock underlaid with coal and slate. Two thousand cubic yards of rock were excavated this year, most of which was used to fill behind the abutment on the opposite side of the river. The continuous high water of last fall prevented the completion of the abutment fill, and the continuance of the lower approach excavation. The construction of the dam, the completion of the lower approach excavation, and the protection of the banks remain to be done. These can all be completed in a single season of favorable weather whenever there is money sufficient available.

The river between Louisa and the Ohio was thoroughly cleared of all snags, stumps, trees, and other obstructions to navigation during October and November, 1888, and is now in excellent condition. There was no money available for like work upon the two forks above.

The work done below Louisa was as follows: Trees taken out 88; average length, 67.4, circumference, 8.4. Snags taken out, 164; average length, 24.3, circumference, 6.4. Stumps taken out, 208; solid rock taken out, 142 cubic yards; loose rock taken out, 376 cubic yards.

These obstructions were at Goff Place, Rice's Bend, Old Licks, Rove Creek, Jonah Rocks, Moore's, White's Creek, Savage Branch, and Catlettsburgh. Obstructions of less importance were taken out at Wiley Hatten's, Nigger Heads, Durbin Creek, Powell's, Rush Creek, Jake Compton's, Belcher Bar, Burgess Landing, Blaine, Fuller's, Potter's, Two-Mile Creek, and Wallace Branch. Owing to the back water from the Ohio River in the Lower Big Sandy during the spring of the year a great many trees settle in the bed and make bad snags. For this reason it is impossible to keep the channel clear of obstructions unless work is done upon it every year.

I would recommend that $500 be annually expended for this purpose, and that an appropriation of $2,500 be made for each of the forks above, viz, Levisa and Tug. The money heretofore recommended to be appropriated to complete the lock and dam now under construction, if made available next season will, in addition to that on hand, complete the contemplated improvement. It is of the greatest importance also that the construction of other locks and dams be started.

Very respectfully,

B. F. THOMAS,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

Commercial statistics for fiscal year ending June 30, 1889.

Articles.	Quantity.	Value.
Beans ..... pounds..	46,949	$1,408.35
Beeswax ..... do....	3,340	668.00
Cattle ..... head..	346	10,380.00
Eggs ..... cases..	6,220	31,000.00
Feathers ..... pounds..	28,380	12,487.20
Furs ..... bags..	222	1,776.00
Ginseng ..... pounds..	5,676	12,771.00
Hides ..... bales..	580	1,270.00
Hogs ..... head..	1,722	13,776.00
Horses ..... do....	37	3,700.00
Leather ..... pounds..	65,000	19,500.00
Lumber, walnut ..... feet, B. M..	727,000	63,500.00
Poultry ..... dozen..	4,221	13,263.00
Roots ..... pounds..	21,180	6,344.00
Sheep ..... head..	1,140	2,850.00
Sorghum ..... barrels..	7,844	62,752.00
Spokes ..... number..	350,000	4,200.00
Staves ..... do....	1,200,000	12,000.00
Tan bark ..... cords..	4,916	39,328.00
Ties, railroad ..... number..	200,000	80,000.00
Timber ..... cubic feet..	4,555,000	659,500.00
Knots, walnut ..... pounds..	25,000	6,250.00
Logs ..... number..	8,500	1,275,000.00
Wheat ..... bags..	8,465	16,930.00
Wool ..... pounds..	20,000	5,000.00
Miscellaneous	.....	2,500.00
Total export	.....	1,511,260.55
Miscellaneous merchandise, 95,000 tons	.....	950,000.00
Passengers carried by steam-boats	.....	28,786.25
Grand total	.....	2,490,046.80

G G 7.

IMPROVEMENT OF GUYANDOTTE RIVER, WEST VIRGINIA.

The Guyandotte River rises in the southwestern part of West Virginia, flows in a northwesterly direction, and enters the Ohio 12 miles above the mouth of the Big Sandy and 39 miles below the mouth of the Great Kanawha.

The project for the improvement of this river was adopted in 1878, and contemplates the formation of a clear channel 122 miles long, with a minimum width of 30 feet and a least depth of 18 inches during five months of the year, by the removal of snags, rocks, and other obstructions. This river was practically closed before work commenced, except during rises of considerable height.

On account of continuous high water, no work was done during the past fiscal year.

The recommendation of the appropriation of $2,000 in my last annual report is respectfully renewed for the fiscal year ending June 30, 1891.

Money statement.

Amount appropriated by act of August 11, 1888	$2,000.00
July 1, 1889, balance available	2,000.00
Amount (estimated) required for completion of existing project	2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Commercial statistics for fiscal years ending June 30, 1888–'89.

Articles.	1888.	1889.
Produce	$58,732	$48,000
Grain	43,400	25,000
Timber, etc	842,200	600,000
Miscellaneous	38,830	50,000
Total exports	983,162	723,000
Total imports	400,000	100,000
Grand total	1,383,162	823,000

G G 8.

IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

The Little Kanawha drains the central portion of West Virginia, rising in Upshur County, and flowing thence in a course a little north of west until it empties into the Ohio at Parkersburgh; its total length is about 150 miles.

The present project for the improvement of the river, adopted in 1876 and modified in 1880, contemplates the construction of a lock and dam to extend slackwater navigation for a draught of 4 feet, a distance of 12 miles, and the improvement of the natural channel of the upper river by the removal of obstructions for a distance of 80 miles, the object of the latter being to obtain a channel of a minimum width of 40 feet with a depth of 2 feet for at least four months of the year.

The work of the past fiscal year has been the continuation of the construction of the lock itself, nothing having been done on the second part of the project, to wit, the improvement of the upper river.

The lock under construction is about 40 miles from the Ohio. Below it are four locks and dams owned and operated by the Little Kanawha Navigation Company. These locks are badly constructed, leaky, and uncertain.

During the past fiscal year the following work has been done:

1st. The river-wall of the lock has been completed.

2nd. The foundation of the land-wall is about one-third completed, a coffer-dam to inclose it having been built and the necessary excavation having been made.

3d. A lock-keeper's dwelling was commenced and so far completed that it will be ready for occupancy by July 10.

4th. The cutting of the different classes of stone required for the completion of the lock continued; in all 245.77 cubic yards of special stone, 136.63 cubic yards of quarry face, and 58.93 cubic yards of backing have been cut, 752.44 cubic yards of masonry laid, and 7,517 cubic yards of earth removed in preparing foundation for land-wall.

It is estimated that $25,353.90 will be required to build the dam, $8,077.45 to build the abutment, and $4,600 to put in the gates and wickets; in all $38,031.35. Allowing for all contingencies, $40,000, is necessary to complete the work, and it is recommended that this amount be appropriated for the fiscal year ending June 30, 1891.

Money statement.

July 1, 1888, amount available		$334.27
Amount appropriated by act of August 11, 1888		25,000.00
		25,334.27
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$11,681.79	
July 1, 1889, outstanding liabilities	3,976.57	
		15,658.36
July 1, 1889, balance available		9,675.91
Amount (estimated) required for completion of existing project		40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

PARKERSBURGH, W. VA., *June* 30, 1889.

MAJOR: I herewith submit my annual report upon the Little Kanawha River improvement.

The work under way is the construction of a lock and dam 2 miles above Burning Springs, and a little over 40 miles from the mouth of the river at Parkersburgh. When completed this will throw good water into the West Fork, the largest tributary of the Little Kanawha. In addition to the work with a view to slackwater navigation, considerable improvement has been made in the open river above by the removal of obstructions, but there has been no money for that purpose the past year. Below the lock, under construction, four locks and dams are owned by the Little Kanawha Navigation Company, which keep up navigation during the greater part of the year, though they are leaky and poorly built, and each year of course shows more decay and adds greatly to their defects.

On account of no money being available, work was not begun until October 1st, when stone-cutting was resumed, excavation of land-wall foundation commenced, and preparations made for laying stone, which was not begun until about the middle of November. All work was closed on account of cold weather about the 20th of December, and was resumed March 1st with a small force of stone-cutters. The construction of the lock was not begun again until after the 1st of May, and the excavation for the land-wall, which had been stopped last November on account of the continued wet weather, was resumed about the middle of May. The construction of a lock-tender's dwelling, a cottage of four rooms, cellar and attic, was begun in April and will be ready for occupancy July 10.

Two hundred and forty-five and seventy-seven hundredths cubic yards of special stone, 136.63 cubic yards quarry face, and 58.93 cubic yards backing stone cut; 792.44 cubic yards of masonry laid, and 7,517 cubic yards of earth taken out of land-wall foundation. Piles and timber for land-wall foundation and chamber floor have been bought and partly made ready for use.

The river-wall of lock is now completed and the cross-wall nearly so, and the upper end of land-wall well started. Three thousand yards of masonry have been put in and over 700 yards of concrete. Stone-cutting is nearly completed, more than 5,500 yards having been made ready for the work. It is believed the present appropriation will complete the lock masonry. The gates and wickets will then be put in; the abutment to build, the dam to construct, the banks to protect, and the lock masonry to protect by sheathing.

The dam is estimated to cost $25,353.90; the abutment, $8,077.45; the gates and wickets, $4,600; a total of $38,031.35. An appropriation of $40,000 will finish the work, and should all be made at one time in order to complete the work in one season, and thus prevent damage to that incomplete, and avoid the expense of removing and replacing the plant.

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

Commercial statistics for fiscal year ending June 30, 1889.

Articles.	Quantity.	Value.
Timber ..... cubic feet..	3,512,000	$632,160.00
Lumber ..... feet, B. M..	5,472,588	164,177.64
Staves ..... number..	4,563,800	82,148.40
Ties, railroad ..... do....	370,126	129,553.75
Wood ..... cords..	410	820.00
Tan-bark ..... do....	320	3,840.00
Coal ..... bushels..	23,425	1,639.65
Oil ..... barrels..	2,850	2,850.00
Grain ..... bushels..	3,000	1,800.00
Miscellaneous ..... tons..	100	10,000.00
Total exports	.....	1,028,989.44
Total imports	.....	100,000.00
Grand total	.....	1,128,989.44

Passenger traffic equals 20,000 passengers through one lock.

G G 9.

IMPROVEMENT OF BUCKHANNON RIVER, WEST VIRGINIA.

The project for the improvement of this stream, approved in 1884, is to clear out that portion of the river between the Three Forks and the town of Buckhannon, a distance of 24½ miles. The obstructions consist of log jams and bowlders, some of which, in the bed of the stream, are estimated to contain 500 cubic yards.

The width of channel sought to be obtained is 30 feet.

Buckhannon River is a tributary of the Tygarts Valley, and rising in the southwestern part of Randolph County, W. Va., flows a little east of north until it falls into the Tygarts Valley River in Barbour County. The distance from the Three Forks to the mouth is 47½ miles and the total length of the stream is about 57 miles.

While this river is not what could be called a navigable water of the United States, the results that have been obtained from its partial improvement have been so great as to warrant its continuance as a business enterprise for the development of the lumber interests of this section.

Before any work was done on this river the annual output of lumber was limited, exceeding in no one year 115,000 linear feet, while in 1888 the amount was 6,000,000 feet, B. M.

During the past year high water prevented work until the fall of 1888, when a party commenced work at a point about 1½ miles above Bean's Mill, and continued up-stream 1¼ miles. About 3,000 cubic yards of rock were removed, and a large drift-pile, containing many valuable logs, was taken out.

The amount estimated for the completion of the improvement is $20,955, and I would respectfully recommend that of this amount $10,000 be appropriated for the fiscal year ending June 30, 1891.

Money statement.

Amount appropriated by act of August 11, 1888	$1,500.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	959.92
July 1, 1889, balance available	540.08

Amount (estimated) required for completion of existing project	$20,955.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Commercial statistics for fiscal years ending June 30, 1887–'88–'89.

Articles.	1887.	1888.	1889.
Logs.....feet, B. M..	2,500,000	6,000,000	5,500,000
Posts.....number..	201,500	.....	.....
Coal.....bushels..	10,000	.....	.....

G G 10.

PRELIMINARY EXAMINATION OF BIG SANDY RIVER FROM CATLETTSBURG TO PIKEVILLE, ON LOUISA FORK, AND TO THE MOUTH OF POND CREEK ON TUG FORK, KENTUCKY.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 10, 1889.

SIR: The river and harbor act of 1888 contained clauses directing the Secretary of War to cause an examination or survey to be made of the "Big Sandy River from Catlettsburg to Pikeville, on Louisa Fork, and to the mouth of Pond Creek on Tug Fork."

By letter of August 28, 1888, this duty was assigned me, but as the data on file in this office was sufficient to determine that the locality was worthy of improvement, no additional field work was required.

In 1874 a survey was made under the direction of Maj. William E. Merrill, Corps of Engineers, extending from Catlettsburg to Pikeville or Piketon, on Louisa Fork, and to Warfield, on the Tug Fork. This survey was made with sufficient detail to enable an approximate location of locks to be made, lines of levels being run throughout.

In 1884 a survey of Tug Fork was made, extending from Louisa to a point 100 miles above; a line of levels was also run over this section.

From the data furnished by these surveys, I have no hesitation in stating that the locality is worthy of improvement.

The improvements that have been made already are as follows: Clearing the main river and the Louisa and Tug forks of snags, bowlders, leaning trees, etc., with a view to aiding push-boat navigation and rafting of logs, and the construction of a lock at Louisa. The walls of the lock are completed as well as the abutment for the dam.

The Big Sandy is formed by the confluence of the Louisa and Tug forks, 26 miles from its mouth. It flows in a northwesterly direction through a narrow valley between rocky hills, and empties into the Ohio at Catlettsburg. The bottom-lands, varying in width, are about 50 feet above low water, and are generally not subject to overflow. The banks, except where the rocky hills immediately border the river, are composed of fine sand, easily washed by the currents, and the many small streams that empty into the river are all sediment-bearing during rainy weather.

The Louisa Fork is the larger of the two that unite to form the Big Sandy; it rises in the southwestern part of Virginia at an elevation of about 1,500 feet above tide-water and flows in a northwesterly direction.

Its banks in many cases are rocky, in others composed of sand and clay. This fork has all the characteristics of mountain streams, a steep average slope, and pools of varying depth, separated by rocky bars that in low water often have but a few inches of water over them. The average fall from Pikeville to Louisa is 149 feet per mile, and the distance between these points is 86½ miles.

The Tug Fork rises in the mountains of McDowell County, W. Va., and flows in a northwesterly direction. It has the same general features as the Louisa Fork, being joined by a succession of pools, separated by rocky bars; below the Falls of Tug, however, the pools are gradually filling up, so that the fall in this locality, which was formerly 3.55 feet in a stretch of 300 feet, was in 1884 but about half a foot.

The average fall in this fork from Pond to Warfield is 1.96 feet per mile, the distance being 23.5 miles, and the average fall from Warfield to Louisa is 1.72 feet per mile, the distance being 34.5 miles.

The only way of securing a sufficient depth of water for purposes of navigation is evidently to canalize the river and its forks by means of locks and dams, especially for a navigation by coal barges.

There have been seasons, however, when the water-supply in the forks would hardly suffice at low water for any but a very limited number of lockages, and then only by using extraordinary care to prevent leakage at the dams.

In consequence of the steep slopes of the forks, and the general clearing away of timber from the banks of the minor streams and their tributaries, which has been going on for years, the rises or tides, as they are called, are sudden, often violent, and generally of short duration; as a consequence fixed dams would in many such cases be a serious obstruction to the quick passage of rafts and coal barges, particularly the former, as they would come out all together with the rise and have to wait the slow process of successive lockages to get by the first lock even, unless the water should be sufficiently high to permit their going over the dam. On this account it would seem that movable dams would be preferable to fixed dams. In addition, in consequence of the sandy character of the soil, and the general clearing up of the banks and adjacent country, which permits the rain-fall to run off rapidly, the water of all these streams is heavily charged with sediment, and it is quite likely that the effect of fixed dams would at times be to cause a shoaling of the pools above them; as the shoaling would, as a general thing, take place during moderate rises, or while the river was falling, the effect of the dams can not be predicated with much certainty, as extensive rises would have a tendency to scour out.

On the other hand, movable dams are more expensive than fixed dams. It is necessary that their foundations should be prepared with great care, and besides the number required on streams like those under consideration is about double the number required where fixed dams are used. On streams like the forks of the Big Sandy, if movable dams were to be used, it would be absolutely necessary to have certain means of communicating information concerning headwater rises to the dams below to give ample time for lowering them.

The commerce of these streams at present is no criterion of what it may be should continuous communication with the Ohio be established, and while not prepared to recommend the expensive method of improvement by movable dams I have no hesitation in recommending the canalization by locks and fixed dams of the Big Sandy and its forks to an extent sufficient to reach well into the coal-fields of the latter. Should it be found that fixed dams will cause a deposit in the pools

sufficient to interfere with navigation, then the dams may be changed so that the scouring effects of high rises may be increased or movable dams for them be substituted. The construction of the dam at Louisa would settle the question of the pools filling up.

The country tributary to the Big Sandy and its forks contains extensive fields of coal and iron, and any system of navigation for these streams must have special reference to their transportation, more especially the former. The new locks now in course of construction on other streams where coal is to be the principal item of commerce in the future have been designed with a view to admitting two barges at a lockage. The lock already constructed on the Big Sandy at Louisa was so designed, and in my opinion any other locks for this stream or its tributaries should be of the same character.

In estimating the number of locks the average lift is taken at from 12 to 14 feet, and the depth on miter sills at 6 feet. This would necessitate the construction of two locks for the Big Sandy in addition to the one already built. The fall between Pikeville and Louisa is 133.75 feet, and nine locks in addition to the one at Louisa would be required to overcome this difference of level.

The fall between the mouth of Pond and Louisa is 105.5 feet, and seven locks would be required above the one at Louisa. In all, nineteen locks and dams would be required to carry slackwater navigation from low water in the Ohio to Pikeville on the Louisa Fork and to the mouth of Pond on the Tug Fork, or eighteen in addition to the one at Louisa.

The estimate for a lock with a width of chamber of 52 feet, length 190 feet between hollow quoins, and 255 feet over all, is as follows where the foundation is rock:

STONE.

Cut stone, dressed face, 1,352 cubic yards, at $9	$12,168.00
Cut stone, quarry face, 944 cubic yards, at $7.50	7,080.00
Squared stone, 2,000 cubic yards, at $6	12,000.00
Backing stone, 4,000 cubic yards, at $5	20,000.00
Special and coping, 843 cubic yards, at $16	13,488.00
Total, 9,139 cubic yards stone	64,736.00
Laying 9,139 cubic yards stone, at $4	36,556.00
Gates and valves	5,500.00
Coffer-dam	4,000.00
Lock above foundation	110,792.00
Rock excavation, 3,500 cubic yards, at $2	7,000.00
	117,792.00
Contingencies and engineering	11,779.20
Total cost of lock	129,571.20

In case of gravel foundation, the cost would be as follows:

980 piles, 15 feet long, $4.50 in place	$4,410.00
Caps and stringers, 68,600 feet, B. M., at $20	1,372.00
Flooring, 78,700 feet, B. M., at $30	2,361.00
Transverse timbers, 9,670 feet, B. M., at $30	290.10
Bolts and spikes, 31,200 pounds, at 6 cents	1,872.00
Labor, capping piles and laying floor	1,000.00
Concrete, 2,600 cubic yards, at $5	13,000.00
Riprap stone, 900 cubic yards, at $1.25	1,125.00

Excavating, 6,000 cubic yards, at 40 cents	$2,400.00
Sheet-piling, 702 feet, at $4.20	2,948.40
	30,778.50
Contingencies and engineering	3,077.85
Total for foundation	33,856.35
Cost of foundation on gravel	33,856.35
Cost of lock above foundation	121,871.20
Cost of lock, gravel foundation	155,727.55

COST OF DAM.

42,182 cubic feet timber under water, at 23 cents	$9,701.86
17,665 cubic feet timber above water, at 23 cents	4,062.95
182,216 feet B. M., sheeting, at $25	4,555.40
46,600 pounds spikes, at 5 cents	2,330.00
2,495 pounds anchoring-rods, at 10 cents	249.50
5,306 cubic yards gravel backing, at 65 cents	3,448.90
11,325 cubic yards riprap stone, at $1	11,325.00
	35,673.61
Contingencies and engineering	3,567.36
Cost of timber dam	39,240.97

ABUTMENT.

750 cubic yards masonry, at $8	$6,000.00
50 cubic yards coping, at $14	700.00
Coffer-dam	800.00
Grillage foundation	500.00
Cost of abutment	8,000.00
Cost of dam	39,240.97
Cost of dam and abutment	47,240.97

It is believed that with due care in locating but six of the eighteen locks required need be built on gravel, so that the estimate of the total cost would be as follows:

Twelve locks, rock foundation, $129,571.20	$1,554,854.40
Six locks, gravel foundation, $155,727.55	934,365.30
Eighteen dams with stone abutments, $47,240.97	850,337.46
Nineten lock-keepers' dwellings, double, $3,000	57,000.00
Total	3,396,557.16

It may be stated that two locks on the Louisa Fork, above the one near its mouth, would carry slackwater navigation well into the coal-fields on that fork above Peach Orchard, and three locks would carry slackwater to Prestonburg, while to reach Warfield on the Tug Fork four locks would be required.

In order, therefore, to reach Prestonburg, on the Louisa Fork, from the Ohio, five locks and dams would be required at a cost of $942,654.75. To reach Warfield, on Tug Fork, from the Big Sandy, four additional locks and dams would be required at a cost of $754,123.80; total, $1,696,778.55. The opening of navigation as indicated above would serve to develop extensive coal-fields; and should the demands of commerce warrant it additional locks may be added to the system.

In consequence of the uncertainty with regard to the filling up of the pools, should fixed dams be used, I would recommend that before act-

ual construction of additional locks and dams is commenced the dam at Louisa be completed and the effect of it carefully observed. This proceeding will be experimental in character, but it will be cheaper to experiment with one dam than with several. Should it be found that the pools will fill up then some other kind of dam will have to be made use of.

The snags, overhanging trees, rocky bars, shoals, and bowlders found in the forks above Louisa seriously interfere at low water with push-boat navigation, little as it requires, and a small annual appropriation to clear these streams would be of great benefit to the inhabitants, who are compelled to depend upon the water-ways for marketing their produce and obtaining supplies, on account of the wretched character of the few roads to be found in this mountainous region.

COMMERCIAL STATISTICS.

Trade of Big Sandy River, West Virginia and Kentucky, for fiscal year 1887–'88.

Articles.	Quantity.	Value.
Beans ..... pounds..	78, 454	$3, 253. 62
Beeswax ..... do....	5, 224	1, 306. 00
Cattle ..... head..	472	13, 216. 00
Coal, cannel ..... tons..	4, 225	12, 675. 00
Eggs ..... cases..	5, 908	26, 586. 00
Feathers ..... pounds..	58, 002	25, 520. 88
Furs ..... bags..	217	1, 801. 10
Ginseng ..... pounds..	7, 590	13, 282. 50
Hides ..... bales..	1, 498	3, 296. 00
Hogs ..... number..	1, 606	12, 848. 00
Horses ..... do....	45	3, 600. 00
Leather ..... pounds..	62, 520	17, 505. 00
Lumber—		
Poplar ..... feet, B. M..	375, 000	9, 375. 00
Walnut ..... do....	26, 000	1, 040. 00
Poultry ..... dozen..	3, 835	11, 505. 00
Roots, assorted ..... pounds..	35, 400	10, 620. 00
Sheep ..... number..	783	1, 957. 50
Sorghum ..... pounds..	2, 679	42, 864. 00
Spokes ..... number..	261, 000	3, 132. 00
Staves ..... do....	375, 000	9, 375. 00
Tan bark ..... cords..	1, 751	24, 514. 00
Ties, railroad ..... number..	350, 000	140, 000. 00
Timber, logs—		
Ash ..... cubic feet..	26, 250	3, 150. 00
Mixed ..... do....	200, 000	20, 000. 00
Oak ..... do....	385, 000	48, 125. 00
Poplar ..... do....	1, 075, 000	161, 250. 00
Walnut ..... do....	4, 185	64, 867. 50
Walnut knots ..... number..	21, 150	8, 460. 00
Wheat ..... bags..	6, 622	13, 244. 00
Wool ..... pounds..	30, 103	7, 525. 75
Miscellaneous	.....	3, 315. 73
Total exports	.....	718, 310. 73
Add imports, miscellaneous merchandise ..... tons..	14, 215	1, 421, 500. 00
Passengers per boats	.....	16, 392. 00
Grand total	.....	2, 156, 202. 73

Very respectfully, your obedient servant,

D. M. LOCKWOOD,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX H H.

IMPROVEMENT OF HARBORS ON LAKE SUPERIOR.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Grand Marais, Minnesota.
2. Harbor at Agate Bay, Minnesota.
3. Harbor at Duluth, Minnesota.
4. Harbor at Superior Bay and St. Louis Bay, Wisconsin.
5. Harbor at Ashland, Wisconsin.
6. Harbor at Ontonagon, Michigan.
7. Eagle Harbor, Michigan.
8. Harbor at Marquette, Michigan.
9. Harbor of refuge at Grand Marais, Michigan.

EXAMINATION.

10. Black River, Lake Superior, Michigan, to deepen channel to depth of 16 feet, and constructing a breakwater.

HARBOR LINES.

11. Harbor lines in Portage Lake, Michigan.
12. Establishment of harbor lines at Marquette, Michigan.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., July 7, 1889.

GENERAL: I have the honor to transmit herewith annual reports upon works of river and harbor improvement at present in my charge, for the fiscal year ending June 30, 1889.

* * * * * * *

Very respectfully, your obedient servant,

JAMES B. QUINN,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

H H 1.

IMPROVEMENT OF HARBOR AT GRAND MARAIS, MINNESOTA

As the number of vessels passing this harbor each year increases the importance of having a good harbor of refuge at this place increases correspondingly. Several railroad surveys have been made for a road from this harbor to the valuable mineral deposits which lie directly north of it, and I believe that the prospects for the construction of such a road are considered very favorable.

The enlargement of the harbor by dredging and extension of the breakwater will probably soon become more urgent than at present.

The safe anchorage area is about 12 acres in extent and has a depth throughout of 16 feet.

The complete improvement as recommended in my annual report for 1888 will cost $165,475 in addition to the amount already expended. Of this amount $15,000 has since been appropriated and is now being expended in enlarging the dredged anchorage area.

If the amounts received for this work from year to year are small it is doubtful if the work can be completed for the estimate. In fact, I think the estimate would have to be increased to cover the extra expense of movement of plant and deterioration of work fully as much as the amount received since the estimate was prepared, and so at present there does not appear to be any necessity for altering the previously stated amount required to complete the improvement.

The contractors commenced dredging at this place on June 17, 1889. The quantity of material excavated to the end of the fiscal year was 14,572.4 cubic yards.

The pier is in fairly good condition, and will probably stand without any extensive repairs for another season.

This work is in the collection district of Duluth, Minn. Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the breakwater at Grand Marais.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT GRAND MARAIS, MINNESOTA.

By act of Congress—	
Approved March 1, 1879	$10,000.00
Approved June 14, 1880	10,000.00
Approved March 3, 1881	20,000.00
Passed August 2, 1882	20,000.00
Approved July 5, 1884	10,000.00
Approved August 5, 1886	10,000.00
Passed August 11, 1888	15,000.00
Total	95,000.00

EXPENDITURES.

Amount expended under approved project to June 30, 1889	$81,461.75
Amount covered by existing contracts	11,502.62
Balance available July 1, 1889	2,035.63
	95,000.00

ESTIMATES.

Original (estimated) amount required to complete the improvement	$139,669.00

Money statement.

1, 1888, amount available		$2,422.23
ıut appropriated by act of August 11, 1888		15,000.00
		17,422.23
1, 1889, amount expended during fiscal year, exclusive of bilities outstanding July 1, 1888	$276.20	
1, 1889, outstanding liabilities	3,607.78	
1, 1889, amount covered by existing contracts	11,502.62	
		15,386.60
1, 1889, balance available		2,035.63
ıount (estimated) required for completion of existing project		44,700.00
ıount that can be profitably expended in fiscal year ending June 30, 1891		44,700.00
ɔmitted in compliance with requirements of sections 2 of river and ıarbor acts of 1866 and 1867.		

act of proposals received for dredging in harbor at Grand Marais, Minn., and opened October 29, 1888, at Duluth, Minn., by Maj. James B. Quinn, Corps of Engineers.

Name and address of bidders.	Prices bid for dredging per cubic yard.
	Cents.
Green's Dredging Company, Chicago, Ill	27½
Knapp & Gillen, Racine, Wis	29
Charles S. Barker, Duluth, Minn	26
Williams, Upham & Co., Duluth, Minn	24

ıtract awarded to Williams, Upham & Co., with the approval of the Chief of Engi-; contract dated November 14, 1888; work to be completed by September 1, 1889.

COMMERCIAL STATISTICS FOR 1888.

er of vessels—		Freight—	
rrived	190	Received	$42,645.22
eared	190	Shipped	2,226.43

Freight received and shipped for eight years.

Year.	Pounds.	Value.	Year.	Pounds.	Value.
	362,000	$30,293.00	1885	583,366	$41,484.86
	500,000	25,691.70	1886	784,750	48,519.60
	396,513	27,575.04	1887		29,059.91
	265,259	30,198.76	1888		44,871.65

Arrivals and clearances of vessels for eight years.

Year.	Arrivals.	Clearances.	Year.	Arrivals.	Clearances.
	108	108	1885	188	190
	124	134	1886	210	210
	131	131	1887	164	164
	153	158	1888	190	190

H H 2.

IMPROVEMENT OF HARBOR AT AGATE BAY, MINNESOTA.

Agate Bay has become an important shipping port for the iron ore of the Vermillion range. It is very small, its area within a line joining the headlands not exceeding 120 acres.

To all winds from the southwest it afforded little or no protection and the reverse swells of a northeast storm obliged vessels to leave the wharves.

To render the harbor secure two piers, or breakwaters, projecting from either point towards the center of the bay have been decided upon as requisite, and 400 feet of the east pier have been constructed at a cost of $20,682.94, including contingencies. This pier has stood remarkably well as far as built, and it is hoped that the extension of 150 feet, which is now under way, will prove as substantial.

The contractor for the extension is very much behindhand with the work, owing partly to bad management and partly to inclement weather. No ice formed during the winter to permit the foundation to be put in as intended. The weather has been rather stormy so far this spring, and has materially interfered with the contractor's efforts to tow the rock from Duluth. As soon as the foundation is completed the crib-work can be speedily put in place.

The benefits resulting from the 400 feet of breakwater so far completed have been greater than was expected. It strongly emphasizes the necessity for the speedy completion of the remainder of this pier. The estimated cost of the completion of the remainder is $62,500. This sum could be most advantageously expended in one year.

If the increase in the amounts of ore shipped from this port continues as heretofore the completion of the work can not beeffected any too soon.

This work is in the collection district of Duluth, Minn. Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the south pier of Duluth Canal, Minnesota.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT AGATE BAY, MINNESOTA.

By act of Congress approved August 5, 1886	$22,500.00
By act of Congress passed August 11, 1888	15,000.00
Total	37,500.00

EXPENDITURES.

Amount expended under approved project to June 30, 1889	$28,911.99
Reserved by Chief of Engineers	94.60
Amount covered by existing contracts	5,213.50
Balance available July 1, 1889	3,279.91
	37,500.00

ESTIMATES.

Estimated amount required to complete the improvement	$221,708.00
Amount appropriated under present project	15,000.00
Balance required for present project	206,708.00
Estimated amount required annually for preserving and maintaining, when improvement is completed	2,000.00

Money statement.

July 1, 1888, amount available		$1,817.06
Amount appropriated by act of August 11, 1888		15,000.00
		16,817.06
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$968.15	
July 1, 1889, outstanding liabilities	7,355.50	
July 1, 1889, amount covered by existing contracts	5,213.50	
		13,537.15
July 1, 1889, balance available		3,279.91
Amount (estimated) required for completion of existing project		206,708.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		62,500.00
Submittted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received for constructing 150 *linear feet of breakwater at Agate Bay Minnesota, and opened November* 1, 1888, *at Duluth, Minn., by Maj. James B. Quinn, Corps of Engineers.*

[Price per running foot.]

Number.	Name and address of bidders.	Foundation.		Crib-work.				Total for foundation and crib-work.
		30 feet wide.	24 feet wide.	Substructure 20 feet wide.	Substructure 24 feet wide.	Superstructure 20 feet wide.	Superstructure 24 feet wide.	
1	Powell & Mitchell, Marquette, Mich.	$38.28	$51.48	$33.82	$46.31	$11.91	$14.29	$14,005.00
2	Charles Berner, Green Bay, Wis	37.00	48.00	33.26	42.62	12.70	14.70	13,562.00
3	Nelson C. Chapman, Minneapolis, Minn	38.00	45.10	35.62	38.00	11.50	13.80	13,257.00
4	Meining & Pearce, Duluth, Minn	39.50	39.50	47.75	47.75	47.75	47.75	20,250.00
5	Thomas Dwyer, Duluth, Minn	21.75	78.17	23.04	40.16	12.65	15.77	12,449.00
6	Hugh Steele, Duluth, Minn	47.85	60.68	30.00	42.60	12.00	14.00	14,849.00
7	William St. Amour, Duluth, Minn	39.00	49.00	28.00	28.00	12.00	14.00	13,450.00
8	J. C. Morrison, Duluth, Minn	49.80	59.61	40.65	60.00	7.15	9.10	16,195.50

Contract awarded to Thomas Dwyer, the lowest bidder, with the approval of the Chief of Engineers.

Contract dated November 21, 1888; work to be completed by October 1, 1889.

COMMERCIAL STATISTICS.

Number of vessels arriving and departing.

Year.	Vessels.	Tonnage.	Year.	Vessels.	Tonnage.
1885	*174	295,800	1887	465	697,500
1886	*263	460,000	1888	749	1,436,000

* In addition to these were numerous north shore and other boats, and daily boats between Duluth and Two Harbors, not included in this statement.

Receipts and shipments.

	1885.	1886.	1887.	1888.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Ore shipped	225,484	304,396	394,252	*455,325
Miscellaneous freight received and shipped	10,895	21,954	6,620	30,552
Total	236,379	326,350	400,872	485,877

*Gross tons.

Estimated value of freight received and shipped, exclusive of ore.

1885	$497,800	1887	$996,000
1886	773,000	1888	212,000

H H 3.

IMPROVEMENT OF HARBOR AT DULUTH, MINNESOTA.

The funds for the continuance of improvements at the harbor of Duluth did not become available in time to permit anything being done during the summer of 1888 beyond the re-adjustment of plans, making such examinations of existing channels and sites of projected channels as the new conditions required, preparatory to the awarding of contracts for the work to be done in the spring of 1889.

All projected work was commenced early this spring and has progressed satisfactorily.

THE DULUTH CANAL OR ENTRY.

The communication between Lake Superior and Superior Bay at Duluth was created by the city of Duluth in the face of many obstructions, the least of which were of a natural character. Its care and preservation were assumed by the United States at the request of the citizens shortly after the work had received considerable damage from a storm which wrecked the Government breakwater under construction to the east of Minnesota Point. The ownership of the canal did not, however, pass to the United States until the attention of the citizens of Duluth was directed to the advisability of this property belonging to the nation. The deed to the lots covered by the canal was formally accepted by the United States by act of Congress of August 11, 1888, and a survey of the property provided for, with a view to its improvement. This survey is not yet completed, and no project for improvement can consequently be submitted at present.

At the time the canal was dug the greatest depth required by the commerce of Lake Superior was but 12 feet, and when 14 feet was adopted for the depth of the canal it was thought that this would probably be as much as would ever be required. To-day full 16 feet depth is required. A minimum depth of 17 feet is maintained in the canal now, and the necessity for a deepening to 21 or 22 feet within three or four years is assured.

The piers lining the canal, which were intended for but 14 feet depth of water, have been made to do duty for 17 feet, but that they will an-

swer for 22 feet is not a reasonable assumption. They are not in the best of order, and will soon require extensive repairs if retained. It would be far preferable to remove them entirely and replace with structures of more modern design.

The south pier will require an extension of about 500 feet to reach the required depth of 22 feet, and I think that the entire renewal of the piers will cost in the neighborhood of $500,000, if built in a substantial manner.

In the absence of the detailed plan, etc., which are not just at present available, it must be understood that this is but a rough estimate.

To preserve the piers in serviceable condition a reserve fund is required of not less than $10,000, since the superstructures are in a rather decrepit state and liable to serious injury by a severe storm.

THE HARBOR BASIN.

No work upon the harbor basin has been done during the past year. Including the area dredged by private parties, it now contains about 126 acres. It will ultimately require to be deepened to 20 feet and greatly enlarged. Fifty thousand dollars could be very profitably expended in enlarging this area during the next year. It is important that this basin be connected by suitable channels with the other channels of Superior and St. Louis bays, which are being improved by the United States.

RICE'S POINT CHANNEL.

The old channel dredged along the east shore of Rice's Point is inadequate for the commerce which would take advantage of a channel in this vicinity if it had sufficient width and depth. The advance of the dock line on the east side of Rice's Point renders the construction of a new channel necessary, but the old channel is not to be obstructed until the new one is completed. Nothing can be done therefore to improve it, and as it is gradually deteriorating the necessity for the speedy completion of the new channel is becoming more and more pressing.

The new channel can not be rendered navigable with the funds at present available, and, although the work is being pushed with a view to making a through cut as soon as possible, it is hardly to be expected that this can be effected this season.

Several private interests are seriously delayed pending the opening of this new channel, and vessel-owners are very anxious to have a suitable connection between the anchorage of Duluth and Superior so that their vessels would not have to go outside in order to go from one harbor to the other. The estimated cost of this channel, as given in my annual report for 1887, is $119,552. Of this sum $28,000 has been allotted from the appropriation for improving Duluth Harbor under the river and harbor act of August 11, 1888. The whole of the remaining ($91,552) can be most judiciously expended during the ensuing year, and, as a proof of the modesty of this recommendation, I respectfully invite attention to the communication from the Duluth Chamber of Commerce and the secretary thereof, hereto appended, in which it is advocated that this channel be not only speedily completed, but should have a width of at least 400 feet, just double the width of the channel projected.

In view of the fact that the vessels recently built for the lake service are over 300 feet long, a 200-foot channel along the ends of the docks is

not wide enough to permit such a vessel to either enter or leave the slips. The suggestion that this channel should have a width of not less than 400 feet is after all a very reasonable one. This channel will become a well-crowded thoroughfare for vessels calling at this port, and in view of the rapidly increasing commerce of this region I am disposed to believe that the width of the projected channel, as shown on the map accompanying my annual report for 1887, should be increased to 400 feet and the estimate increased to $219,552, leaving $191,552 to be provided, of which sum $91,552 can be judiciously expended next year, as before stated.

NORTH SHORE CHANNEL, ST. LOUIS BAY.

Of the $80,000 appropriated by the last river and harbor bill for the improvement of Duluth Harbor, $40,000 was provided for the commencement of work upon a channel along the north shores of St. Louis Bay to connect the deep water at Connor's Point with the deep water of the St. Louis River at Grassy Point. This sum is hardly sufficient to make a single cut about 40 feet wide and 16 feet deep, and unless widened to the proposed width will be of but little practical use. This channel should be really made 400 feet wide, for the reasons given in the letters from the Duluth Chamber of Commerce before alluded to, but it is likely that the 200-foot channel will be sufficient to meet the demands of commerce for four or five years.

The manufacturing industries of Duluth are locating at West Duluth, and this channel on the north shore of St. Louis Bay is essential to their welfare. If the manufacturing concerns, briefly alluded to in the letter of Mr. O. H. Simonds, hereto annexed, are able to make the commencement they have with the indifferent navigation through St. Louis Bay which at present exists, the possibility of the future of a suitable channel giving access to Lake Superior if supplied can hardly be exaggerated.

The cost of a 200-foot channel was estimated at $163,000. Of this there remains to be supplied $123,000. If this entire amount could be made available for work next year it would result in giving a much better and more useful channel than could be obtained with the same funds if the work is distributed over several years.

ST. LOUIS RIVER.

The rapid growth of Duluth has produced a market for large quantities of the fine building stone quarried at Fond du Lac. In consequence of this the navigation of the St. Louis River has reached some importance, and it is likely that a navigable depth of 10 feet will soon be necessary to accommodate it. The removal of the obstruction referred to in the letter of Mr. Davis, secretary of the Duluth Brownstone Company, hereto appended, would cost with contingencies $2,444.42. This amount could be profitably expended during the coming year.

STEAM-LAUNCH.

The steam-launch provided for in the last river and harbor bill has been purchased and has very much facilitated the inspection and examination of the works in progress.

CONCLUSION.

All the dredged areas of Duluth Harbor and those projected will eventually have to be deepened to 20 or 22 feet, and all original esti-

mates will have to be correspondingly increased. This subject I have not deemed expedient to discuss in detail at present, since it will probably be some time before the greater depth will be required. I have not, furthermore, made any attempt to discuss the advisability of continuing the improvements at this harbor, since I believe the letters accompanying this report, and which have been previously alluded to, contain sufficient facts upon which to found an intelligent opinion.

Work during the fiscal year just closed was as follows: The channel east of Rice's Point has been dredged about 45 feet wide and 17 feet deep for a distance of 2,640 feet, and the channel on the north shore of St. Louis Bay has been dredged about 50 feet wide and 16 feet deep for a distance of about 7,300 feet. The quantity of material removed from former channel was 58,685.5 cubic yards, and from the latter 114,174.3 cubic yards.

CONDITION OF WORK.

The canal piers are in fairly good condition, but liable to serious damage from severe storms. The entire work will eventually require to be replaced with more durable material. The ruling depths in the portions of the harbor dredged by the United States are—

	Feet.
In canal	17
In the inner basin or harbor	16
In Blast Furnace Channel to a point opposite Elevator E	16
From point opposite Elevator E through dredged channel along east side of Rice's Point to the St. Louis River	12
In channel on north shore of St. Louis Bay for a distance of 7,300 feet	16
In new channel east of Rice's Point for a distance of 2,640 feet	17

RECOMMENDATIONS FOR NEXT YEAR.

Reserve fund for canal piers	$10,000.00
For enlarging the harbor basin	50,000.00
For Rice's Point Channel	91,552.00
For north shore channel, St. Louis Bay	123,000.00
For the St. Louis River	2,444.42
Total	276,996.42

This work is in the collection district of Duluth, Minn. Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the outer end of the south pier of Duluth Canal, Minnesota. A range-light is being built on the inner end of the south pier of the Duluth Canal.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT DULUTH, MINNESOTA.

By act of Congress approved—	
March 3, 1871	$60,000.00
June 10, 1872	50,000.00
Allotted from act approved March 3, 1873	36,049.20
By act of Congress approved—	
June 23, 1874	10,000.00
March 3, 1875	35,000.00
August 14, 1876	15,000.00
June 18, 1878	30,000.00
March 3, 1879	25,000.00
June 14, 1880	25,000.00
March 3, 1881	40,000.00
By act of Congress passed August 2, 1882	45,000.00
By act of Congress approved—	
July 5, 1884	45,000.00
August 5, 1886	56,250.00
By act of Congress passed August 11, 1888	80,000.00
Total	552,299.20

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of soundings, superintendents, buoying, and contingencies, exclusive of amount covered by existing contract:

Class of work.	To June 30, 1889.	Prior to present project.	Under present project to June 30, 1889.*
Breakwater	$110,000.00	$110,000.00	.....
Canal piers, etc	77,215.26	45,608.33	$31,516.93
Dredging	311,116.42	114,953.48	196,162.94
Reserved by Chief of Engineers	227.90	.....	227.90
Steam launch	1,909.03	.....	1,909.03
Total	500,468.61	270,651.81	229,816.80

* Adopted in 1881.

Amount required annually for preserving and maintaining $10,000

Money statement.

July 1, 1888, amount available		$3,799.14
Amount appropriated by act of August 11, 1888		80,000.00
		83,799.14
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$15,446.47	
July 1, 1889, outstanding liabilities	16,522.08	
July 1, 1889, amount covered by existing contracts	34,500.17	
		66,468.72
July 1, 1889, balance available		17,330.42
Amount (estimated) required for completion of existing project		324,526.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		276,996.42
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received for dredging in the harbor of Duluth, Minn., and opened November 13, 1888, at Duluth, Minn., by Maj. James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Dredging in Superior Bay east of Rice's Point, per cu. yd.	Dredging in St. Louis Bay west of Rice's Point, per cu. yd.
		Cents.	*Cents.*
1	Green's Dredging Company, Chicago, Ill	20	20
2	Knapp & Gillen, Racine, Wis	17	17½
3	Charles S. Barker, Duluth, Minn	16	16
4	Williams, Upham & Co., Duluth, Minn	15	15½

Contract awarded to Williams, Upham & Co., with the approval of the Chief of Engineers. Contract dated December 15, 1888; work to be completed by August 15, 1889.

COMMERCIAL STATISTICS.

Comparative statement of arrivals and clearances of vessels at Duluth for twelve years.

Year.	Arrivals.	Clearances.	Total.	Years.	Arrivals.	Clearances.	Total.
1877	329	228	557	1883	796	779	1,575
1878	406	343	749	1884	888	903	1,791
1879	502	497	999	1885	808	899	1,797
1880	524	524	1,048	1886	1,026	995	2,021
1881	666	660	1,326	1887	1,237	1,238	2,475
1882	833	832	1,665	1888	1,100	1,100	2,200

Average vessel tonnage.

Year.	Tons.	Year.	Tons.
1885	761	1887	812
1886	778	1888	887

Value of exports from Duluth.

1886	$2,419,847
1887	3,898,125
1888	1,205,670

The "in transit trade."

Year.	Value of merchandise.	Duties.
1885	$96,385	$46,971.11
1886	94,540	52,576.97
1887	82,415	52,205.49
1888	245,094	173,048.16

Canadian fish received.

Year.	Fresh.	Salt.
	Pounds.	*Pounds.*
1886	758,673	19,717
1887	793,569	23,806
1888	331,667	51,552

Receipts of flour and coal.

Year.	Flour for shipment eastward.	Coal for six years (Duluth and Superior).	Year.	Flour for shipment eastward.	Coal for six years (Duluth and Superior).
	Barrels.	*Tons.*		*Barrels.*	*Tons.*
1883	891,800	420,000	1886	1,357,000	736,000
1884	814,300	372,000	1887	1,322,715	1,041,000
1885	1,155,000	695,000	1888	1,747,176	1,435,000

LUMBER.

The product of the mills in the Duluth district, in which are included the mills of the iron cargo, Douglas County mills, and the mills at Thomson, Cloquet, and Barnum, was as follows (from the Duluth Board of Trade report):

Year.	Lumber.	Laths.	Shingles.
	Feet.	*Number.*	*Number.*
1888	262,320,000	36,190,000	99,384,000
1887	209,850,000	34,250,000	74,300,000
Increase	52,480,000	1,940,000	25,084,000

The storage capacity of Duluth elevators is 19,550,000 bushels. The following table gives the receipts and shipments of wheat for eighteen years at Duluth:

Year.	Receipts.	Shipments.	Year.	Receipts.	Shipments.
Year ending Dec. 31—	*Bushels.*	*Bushels.*	Year ending Aug. 31—	*Bushels.*	*Bushels.*
1888	7,993,388	13,482,629	1879	1,524,065	1,487,222
1887	17,136,275	19,518,586	1878	1,903,090	1,783,359
1886	22,532,574	17,668,251	1877	460,595	503,889
1885	14,869,675	14,065,775	1876	1,451,190	1,376,392
1884	13,722,930	11,551,582	1875	1,137,721	1,081,194
Year ending Aug. 31—			1874	2,407,476	2,434,176
1883	4,707,803	4,586,908	1873	1,981,453	1,583,172
1882	3,266,242	3,325,498	1872	931,611	951,046
1881	3,332,176	2,865,536	1871	556,783	544,848
1880	1,347,679	1,453,674			

Opening and closing of navigation.

Year.	Opening.	Closing.	Year.	Opening.	Closing.
1885	Apr. 27	Nov. 29	1887	May 4	Dec. 28
1886	May 7	Dec. 14	1888	May 11	Dec. 31

NOTE.—The dates of opening and closing of navigation by years, 1865–'84, are given in Annual Report of the Chief of Engineers for 1885.

LETTER FROM COMMITTEE OF CHAMBER OF COMMERCE.

DULUTH, MINN., *June* 18, 1889.

DEAR SIR: The Chamber of Commerce of the city of Duluth respectfully present to you that the actual needs of commerce require more rapid work upon the harbor of Duluth and its approaches than has been done up to the present time. That this may be inaugurated requires as the first step very large estimates to be made by you, with a view to accomplishing a large amount of work in the following year. We therefore urge upon your attention the following points:

(1) The ship-canal through Minnesota Point, the entrance to our harbor, should receive attention. The piers require rebuilding in such substantial manner as to be permanent, and your estimate of an amount as large as you can use on them during the year would be fully warranted.

(2) The main channel down the bay, east side of Rice's Point, should be at once dredged out 400 feet in width to a connection with the natural channel between Rice's and Conner's Points. This is needed now to accommodate the movement of vessels between the docks on this side and those at West Superior and the north shore of St. Louis Bay and Grassy Point.

(3) The area of our main anchorage ground between Rice's and Minnesota Points should be so increased by dredging as to afford about double the present room for vessels to use as a harbor of refuge, for the reason that in case of severe weather all vessels bound for all parts of the bays at the head of Lake Superior must use the

ship-canal for entrance, and this harbor of refuge for temporary anchorage, before proceding to their docks of discharge and reloading.

(4) The channel on the north shore of St. Louis Bay, from Rice's Point to deep water at Grassy Point, should be at once widened to 400 feet. Manufacturing establishments on the north shore of St. Louis Bay and Grassy Point are now constructed, which will require large shipping facilities, and they have deep water in front of their works. The Government is only asked to provide additional depth in the connecting channel between this deep water and the natural channel near Rice's Point.

If your estimates can be made to include these items they will be very much larger than the estimates of any previous year, but we are sure that the situation thoroughly warrants such action on your part.

It is not proposed or expected business and developments that furnish the cause for this immediate improvement, but business and shipping already in existence, and suffering greatly for want of this work, that full use may be made of this great harbor and its connecting water-ways.

The work is national in its character and in the benefits which will result therefrom, and directly affects many great States.

C. H. GRAVES,
JAS. T. HALE,
J. D. ENSIGN.

Maj. JAMES B. QUINN,
Corps of Engineers, U. S. A.

LETTER FROM SECRETARY OF CHAMBER OF COMMERCE.

[Supplementary statistics by the secretary of the Duluth Chamber of Commerce.]

Chamber of Commerce, Secretary's Office.

SIR: I have been directed by the harbor committee of the chamber of commerce to supplement the report given above with such facts as will tend to support the statements of the committee as to the needs of the water-ways in and about the bays of Duluth and St. Louis.

At present the channel from Duluth to Superior is altogether inadequate to accommodate the vessels of the larger class which ply between these two points and the lower lakes.

They are now subjected to the necessity of making a long circuit of 7 or 8 miles, while with an enlarged and deepened channel between the two cities the distance could be covered within 2 miles, at a great saving of time and expense. Hence with our rapidly-increasing and enlarged tonnage it seems to be indispensable that this channel should at once be enlarged to the minimum depth required by our shipping and of the width urged by the committee. This will be the work of two or three years under the most favorable circumstances; therefore it is to be hoped that you will ask for the largest amount which you may be able profitably to expend during the ensuing year.

By way of fortifying this claim permit me to give you a few comparative statistics showing the rapid growth of the business done in the harbor:

Beginning with the growth of the wheat trade, let me observe that the aggregate receipts and shipments for 1883 amounted to 9,294,711 bushels; 1884, 25,274,512 bushels; 1885, 28,934,450 bushels; 1886, 40,307,665 bushels; 1887, 37,114,321 bushels.

The past year having been one of short crops, the bulk of grain handled has not been so great, but there is every indication that the yield of the crop year of 1889–'90 will far exceed that of any of the previous years.

The growth of the flour trade, as shown by shipments, has been as follows:

	Barrels.		Barrels.
1883	891,800	1886	1,357,000
1884	814,300	1887	1,322,715
1885	1,1[illegible]5,000	1888	1,747,176

The increase in the elevator capacity will appear in the following figures:

	Bushels.		Bushels.
1883	3,160,000	1886	11,150,000
1884	9,410,000	1887	19,450,000
1885	9,910,000	1888	20,950,000

The increase in the arrivals and clearances and in the tonnage of freight since 1885 is as follows:

Year.	Vessels.	Tons.	Year.	Vessels.	Tons.
1885	1,503	1,372,233	1887	2,476	2,021,788
1886	2,180	1,694,831	1888	2,200	1,943,781

The coal tonnage at the head of the lake for the years named is as follows:

	Tons.		Tons.
1883	420,000	1886	736,000
1884	372,000	1887	1,041,080
1885	695,000	1888	1,435,000

These comparative statistics constitute the most formidable argument that can be urged in behalf of the rapid and speedy enlargement both of the harbor area and of the channels connecting the two points on the opposite sides of the bay.

The next point to be considered is the demand for a greatly-enlarged channel-way from Rice's to Grassy Point, on the north side of St. Louis Bay.

The facts which support the demand of the committee for enlarged appropriations may be summed up as follows:

The suburb known as West Duluth less than two years ago was simply a wilderness, covered with trees and undergrowth, with scarcely a building for any purpose within its limits. To-day it is a community of not less that 2,000 souls, which number must be at least doubled within the next year. This rapid growth is the result of the establishment of enormous manufacturing industries on the shore of the bay, and the consequent necessity of rapid transit by water from the lower bay, in order that the raw materials and manufactured products of these industries may be handled with ease, economy, and dispatch.

The following are some of the establishments now in progress and soon to be put in actual operation:

(1) The Duluth Iron and Steel Works. These works are designed for the reduction of the rich ores of the Vermillion region to pig-iron and the manufacture of steel, with all the train of industries that result therefrom.

This establishment will employ within the next two years not less than from two to three hundred men, possibly more.

(2) The Minnesota Car Works, whose plant covers several acres of ground, and whose output is expected to be not less than fifteen finished cars per day. It will employ from eight hundred to one thousand men.

Its docks, together with that of the iron and steel works, are already partially constructed out to the dock-line.

(3) The Iron Bay Manufacturing Company, for the production of heavy machinery, engines, boilers, hoisting apparatus, and other appliances used in mining.

This plant is also located on the bay front, and needs ample facilities for handling its raw materials and products, by water as well as by rail. It will employ not less than three hundred men.

(4) The Glenn Boiler Works, in the vicinity of Oneota. These works will produce boilers of the largest class, and its productions have already an established reputation and extensive market along the lakes, as well as to the westward on the railway lines toward the Pacific.

Other manufacturing establishments, projected and in actual operation, of greater or less importance, demand that the water-ways connecting with the harbor and the lake should be opened wide and deep for the convenient handling of their varied productions.

Superadded to this, the deep-water channel above Grassy Point and extending to Fond du Lac, with short reaches of shallow water, should be made the more easily available for the extension of our manufacturing system along St. Louis River and Bay by the improvement of the channel to which the committee invite your attention.

As the average tonnage of vessels doing business at the head of the lakes is increasing from year to year, the necessity of these improvements becomes more and more manifest. As an illustration of this increase, I conclude this statement by quoting the statistics referring to this subject.

VESSELS.

The average tonnage of vessels trading at this point was in—

	Tons.
1885	761
1886	778
1887	812
1888	887

The increase of this average tonnage over previous years is as follows:

	Tons.
1886	17
1887	34
1888	75

That this increase will continue to be rapid for years to come, and until it reaches a maximum requiring a depth of not less than from 17 to 20 feet, is apparent to all observers of the growing commerce of our great water-ways.

With great respect, I am yours, very truly,

WILLIAM F. PHELPS,
Secretary.

Major JAMES B. QUINN,
Corps of Engineers, U. S. A.

LETTER FROM WEST DULUTH LAND COMPANY.

DULUTH, MINN., *June* 8, 1889.

DEAR SIR: As I understand the time approaches for the compilation of your report to the War Department, I beg to call your attention to the remarkable development now taking place at West Duluth and farther up the St. Louis River, as bearing on the question of dredging a suitable channel in the Bay of St. Louis for the free passage of Lake Superior vessels.

West Duluth is situated on the Minnesota side of St. Louis Bay, at Grassy Point, and though less than two years old, has within its limits railroad-car shops, rolling-mills, forge works, iron and steel works, machine-shops, boiler-shops, foundries, and wood-working establishments, besides many smaller industries. Arrangements have also been partially made for the early establishment of a large ship-yard, stove works, and large wagon-shops.

All of the foregoing rely more or less on lake vessels to supply them with material and fuel.

In addition to the above, there are strong prospects of the immediate improvement of the extensive water-power in the St. Louis River, which will introduce large industries near Fond du Lac.

From a careful collection of reports made to me by the managers of the several establishments now in operation this year, I estimate the quantity of material and fuel that should be delivered at West Duluth docks in Lake Superior bottoms to be about 75,000 tons per annum.

At the present rate of growth and development this amount will be increased five-fold within two years.

To safely and economically handle this freight a channel should be cut in St. Louis Bay of full depth and at least 200 feet wide, extending from deep water at Rice's Point to deep water at Grassy Point.

Yours, truly,

O. H. SIMONDS.

Major JAMES B. QUINN,
Corps of Engineers, U. S. A.

LETTER FROM DULUTH BROWN STONE COMPANY.

DULUTH, MINN., *June* 29, 1889.

DEAR SIR: The undersigned company is the owner of a quarry of brown sandstone of unlimited quantity, which is situated at the foot of the rapids of the St. Louis River, in the State of Wisconsin, being lots 1 and 2, section 7, embracing 51 acres, more or less. The output of the quarry each year for the past three years has been from two to six thousand cords, and the quantity required for use each year is increasing. We have been put to a large expense already, and have expended nearly $6,000 in

dredging channel and removing bars to reach the quarry. We address you in the hope of getting you, in your next report to the Department, to recommend such an appropriation as, in your judgment, you think sufficient to give us a depth of, say, 9 feet of water, and a width of channel of 50 feet. The distance necessary would be about 1,500 feet, in which there is now a depth of 6 feet.

Yours, very truly,

DULUTH BROWN STONE CO.
W. W. DAVIS,
Secretary.

Maj. JAS. B. QUINN,
Corps of Engineers, U. S. A.

H H 4.

IMPROVEMENT OF HARBOR AT SUPERIOR BAY AND ST. LOUIS BAY, WISCONSIN.

The natural opening between Lake Superior and Superior Bay is at the southerly extremity of Superior Bay. This opening was improved somewhat before 1866 by the citizens of the city of Superior, and since that time the improvement has been continued by the United States.

The piers bordering the entry have now reached an aggregate length of 5,650 feet, and are in a rather decrepit state and will need considerable repairs. A reserve fund of $15,000 has been maintained to meet such exigencies as may arise at any time from a severe storm. The renewal of the superstructure at current rates would cost $141,250. Manifestly the reserve fund should be increased to at least $25,000, since with the present small sum available it is impossible to undertake any repairs of even a minor character, in view of the possibility that a much greater sum than is available may be needed to repair the damages resulting from a severe storm.

The shore is building out rapidly on the Wisconsin side, and the extension of the pier on this side will soon be necessary. If it is extended so as to provide for a depth of 20 feet of water, this extension will cost $30,250. This extension could be advantageously made during the ensuing year.

CHANNEL IN SUPERIOR BAY.

The channel in Superior Bay is very narrow, and although there is a minimum depth of 16 feet it is not unusual for vessels navigating it to run aground on the sides. Considerable dredging has been done to widen and straighten this channel, but to meet the full requirements of the commerce using it, it should be widened to 400 feet, as suggested by the committee of the Superior Chamber of Commerce, whose letter is hereto appended.

To give a 400-foot channel as desired will require the removal of 777,667 cubic yards of material at a cost of $139,980. This channel needs to be permanently marked so as to diminish the risks which attend its navigation. One hundred thousand dollars can be advantageously expended on this during next season.

QUEBEC DOCK CHANNEL.

The channel leading from the main ship-channel to the Quebec dock and Northern Pacific Railroad dock requires to be enlarged about 100 feet. This work will cost about $12,308, of which sum $6,000 could be most economically expended next year.

The Nemadji River debouches near these docks and much of the débris transported by the river is deposited in their vicinity, and it is hardly likely that this dredged area can be maintained without constant effort.

THE NEMADJI RIVER.

This river is getting to have considerable importance, from the fact that there are saw-mills and brick-kilns located upon it, the products of which are transported by water to Superior and elsewhere. The bar at the mouth is a great obstruction and will require dredging to the amount of about $5,000 to create a channel through it. This amount could be judiciously expended during the coming year.

CHANNEL ALONG WISCONSIN DOCK-LINE, ST. LOUIS BAY.

The completion of the channel along the Wisconsin dock-line in St. Louis Bay will cost as projected $112,156. As indicated in the letter of the Chamber of Commerce before alluded to, it should have a width of 400 feet. This would increase the estimated amount for a channel here to $231,317. It is likely, however, that the extension of this channel from the point already dredged to Grassy Point will meet the necessities of commerce for some time, if dredged to the dimensions already projected. The widening of the present dredged channel to 400 feet will require an expenditure of $50,400, and in view of the fact that vessels are very much cramped for room when entering or leaving the docks bordering this channel and consequently liable to serious injury by running into the bank, there is no question but that this $50,400 could be judiciously expended during the ensuing year.

The statistics of the commerce which enters and uses the channels and water-ways of Superior, and which are hereto appended, will give sufficiently convincing reasons for the construction and extension of the improvements under way for this locality.

Work during the past year has been confined to dredging in the channel between Connor's Point and the entry, straightening and widening the channel at the "middle ground," about one-half mile north of Safford's Pier. The amount of material excavated to the end of the fiscal year was 75,700 cubic yards.

CONDITION OF THE IMPROVEMENT.

The entry piers are in fair condition, but need extensive repairs, particularly the superstructure, to render them secure. The beach protection is still intact. The ruling depths in the channels dredged by the United States are:

	Feet.
From Connor's Point to the entry	16
From Northern Pacific Railroad Dock to the entry	16
In front of Quebec Dock	16
Throughout the entry between piers	16

RÉSUMÉ OF RECOMMENDATIONS.

For reserve fund for entry piers	$10,000
For extension of the south pier of entry	30,250
For channel in Superior Bay	100,000
For enlarging Quebec Dock Channel	12,308
For dredging at mouth of the Nemadji River	5,000
For widening channel in St. Louis Bay	50,400
Total	207,958

Superior, West Superior, and Connor's Point are in the collection district of Superior, Wis.; Marquette, Mich., being the port of entry. The nearest light-house is situated on the entry piers at Superior, Wis.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT SUPERIOR BAY AND ST. LOUIS BAY, WISCONSIN.

By act of Congress approved—	
March 3, 1867	$63,000.00
April 10, 1869	45,000.00
July 7, 1870	40,000.00
March 3, 1871	60,000.00
June 10, 1872	50,000.00
Allotted from act approved March 3, 1873	63,950.80
Allotted from appropriation for "Repairs of harbors on Northern Lakes"	5,433.00
By act of Congress approved—	
August 14, 1876	3,000.00
June 18, 1878	3,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 188	10,000.00
August 2, 1882	40,000.00
July 5, 1884	45,000.00
August 5, 1886	22,500.00
By act of Congress passed August 11, 1888	50,000.00
Total	510,883.80

EXPENDITURES.

Amount expended under origiual project, adopted in 1867	$258,000.00
Amount expended under project recommended by Board of Engineers in 1873	77,513.26
Amount expended under present project to June 30, 1889, exclusive of existing contracts	128,371.06
Reserved by Chief of Engineers	4.30
Total	463,888.62

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies, exclusive of existing contracts:

Repairs and beach protection	$13,233.00
Construction and repairs to piers	318,173.53
Dredging	132,477.79
Reserved by Chief of Engineers	4.30
Total	463,888.62
Estimated amount required annually for preserving and maintaining	10,000.00

Money statement.

July 1, 1888, amount available		$10,270.33
Amount appropriated by act of August 11, 1888		50,000.00
		60,270.33
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$6,762.97	
July 1, 1889, outstanding liabilities	6,512.18	
July 1, 1889, amount covered by existing contracts	28,402.00	
		41,677.15
July 1, 1889, balance available		18,593.18
Amount (estimated) required for completion of existing project		291,736.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		207,958.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received for dredging in Superior Bay and St. Louis Bay, Wis.

[Opened October 29, 1888, at Duluth, Minn., by Maj. James B. Quinn, Corps of Engineers.]

No.	Name and address of bidder.	Per cubic yard.
		Cents.
1	Green's Dredging Company, Chicago, Ill	24
2	William , Upham & Co., Duluth, Minn	14½
3	Charles S. Barker, Duluth, Minn	14½
4	Knapp & Gillen, Racine, Wis	19

Contract awarded to Charles S. Barker, with the approval of the Chief of Engineers. Contract dated November 12, 1888; work to be completed by October 1, 1889.

COMMERCIAL STATISTICS.

[Furnished by W. F. Street, deputy collector customs.]

Comparative statement of arrivals and clearances of vessels for six years.

Year.	Vessels.	Tonnage.	Year.	Vessels.	Tonnage.
1888	812	901, 139	1885	200	189, 768
1887	462	410, 838	1884	194	115, 872
1886	316	271, 190	1883	2)	15, 468

Receipts of freight by lake during 1888.

Commodities.	Quantities.	Value.
Coal ..... tons..	630, 258	$3, 151, 265
Iron ..... tons..	5, 836	116, 729
Log ..... M feet..	7, 000	42, 000
Fire-brick ..... tons..	400	46, 600
Iron and steel rails ..... do...	10, 270	308, 100
Merchandise ..... do...	2, 600	260, 000
Salt ..... do...	11, 966	239, 720
Total	.....	4, 164, 414
Receipts in 1887	.....	2, 158, 055
Increase	.....	2, 006, 359

Shipments by lake during 1888.

	Value.
Wheat, flour and brick	$4, 935, 241
Shipments in 1887	2, 567, 459
Increase	2, 367, 782

Comparative settlement of receipts and shipments for five years.

Years.	Value.	Years.	Value.
1888	$9, 099, 655	1885	$934, 905
1887	4, 725, 514	1884	484, 395
1886	3, 253, 248		

LETTER FROM CHAMBER OF COMMERCE.

SUPERIOR, WIS., *June* 17, 1889.

SIR: Replying to your communication of the 6th instant to the secretary of the chamber of commerce of Superior, inviting suggestions as to the improvement of Superior Harbor, the undersigned, a committee appointed for that purpose, beg leave respectfully to indicate to you the sense of the chamber in that matter, as expressed at a recent meeting thereof.

First. That the natural entry should be deepened and preserved by the construction of new and substantial piers of wood or stone, the latter preferred, whenever the present piers need to be rebuilt.

Second. That the natural channel within the Bay of Superior be widened and deepened so as to freely float the largest vessels navigating the lakes.

Third. That the Quebec Channel be widened at its angles and made deep enough to enable the largest vessels to reach the Northern Pacific Wharf in Superior.

Fourth. That a channel deep enough for the largest vessels connecting with the main channel of the bay be dredged in the Nemadji River for a distance of one-half a mile from its mouth, in accordance with the plan adopted by the special Board of Engineers, consisting of Colonel Houston, Major Mackenzie, and Major Allen, in 1881. The chamber is especially desirous of seeing Nemadji River dredged in view of proposed improvements in the way of saw-mills and docks to be constructed soon on that river.

Fifth. That Channels be dredged parallel to the dock lines in the St. Louis Bay to accommodate the business of that bay.

Sixth. That the sand, trees, shrubs, and other materials on Minnesota and Wisconsin Points be preserved from trespassers and the action of the elements, and that the Government acquire ownership or control of Minnesota Point, the preservation of which is so essential to the maintenance of the harbor of Superior.

The chamber of commerce instructs the committee to protest against any new canal through Minnesota Point, or the neglect or abandonment of the natural entrance.

Very respectfully,

JAMES BARDON,
L. F. JOHNSTON,
L. D. NEWTON,
Committee.

Major JAMES B. QUINN,
Corps of Engineers, U. S. A.

LETTER FROM CHAMBER OF COMMERCE.

WEST SUPERIOR, WIS.,
June 24, 1889.

SIR: Presuming that suggestions from this chamber relative to the improvement of Superior Harbor will be received by you in the proper spirit, we would respectfully call your attention to what we deem expedient and necessary in that direction, as follows:

First. That the natural entry to the harbor should be preserved and deepened.

Second. That the natural channel of the river as it passes through Superior Bay should be widened to a uniform width of not less than 400 feet, and deepened to a uniform depth of not less than 17 feet.

Third. That Howard's Pocket be dredged to a uniform depth of 17 feet between dock lines.

Fourth. That the channel along the Wisconsin side of St. Louis Bay be dredged to a uniform depth of 17 feet up to the deep water near the St. Paul and Duluth Bridge.

Fifth. That the channel of the St. Louis River, adjoining and just above the St. Louis River, be straightened and dredged to a depth sufficient for the passage of deep-draught vessels to the dock slip of the West Superior Iron and Steel Company.

Sixth. This chamber joins the Duluth chamber of commerce in recommending that the channel on the east side of Rice's Point be dredged to a uniform width of 400 feet and a uniform depth of 17 feet, but does not desire that appropriations for the Wisconsin channels be lessened on that account. It is our desire simply to record our opinion that such a channel would be of great value to this harbor and its commerce.

Seventh. This chamber joins the Superior chamber in recommending that the main channel of the bay be connected with Nemadji River by a deep channel for a distance

of one-half a mile from the mouth of the Nemadji, in accordance with the plans adopted by a special board of engineers, consisting of Colonel Houston, Major Mackenzie, and Major Allen, in 1881.

GEO. D. MOULTON,
J. T. MURPHY,
HENRY A. SWENSON,
Committee of the West Superior Chamber of Commerce.

Major JAMES B. QUINN,
Corps of Engineers, U. S. A.

H H 5.

IMPROVEMENT OF HARBOR AT ASHLAND, WISCONSIN.

This work was transferred to me by Maj. Charles E. L. B. Davis, Corps of Engineers, September 4, 1888.

Beyond the preparation of projects for building breakwaters, etc., and the advertising for bids for a jetty to close the opening in Chequamagon Point, nothing had been done.

The project for a jetty at Chequamagon Point was abandoned at the request of the citizens of Ashland, and a new project was called for.

The Business Men's Association informed me that it was the wish of the citizens of Ashland that the money available for the improvement of their harbor should be expended partly for dredging along the docks and partly for the construction of a breakwater projecting into the bay in such a manner as would give protection to the wharves of the city from the waves which rolled in through the entrance to the bay or were generated within the bay itself. A project based upon this expression of opinion was prepared and forwarded to the Engineer Department, but, inasmuch as the appropriation was granted upon estimates which contemplated a breakwater solely, it was disapproved.

A second project was then submitted, but did not meet with approval, as the form of construction was deemed faulty.

A third project was then prepared, and was approved, with the exception of the location, which was changed to a line previously suggested.

The inner end of the breakwater was to be placed 1,000 feet outside of the established dock line, and was to be 4,650 feet long. The location of the breakwater is shown on the accompanying chart of Ashland Harbor.

The plan of breakwater adopted is essentially a slab-pier, strengthened with piles and heavily ballasted with rock. The accompanying plans will explain the character of this construction.

Bids for the construction of this breakwater were opened April 5, 1889. Seventeen bids were received, ranging in price from $11.45 up to $26 per running foot. Mr. Hugh Steele, being the lowest bidder, was awarded the contract for constructing the whole 4,650 feet, and he commenced work May 1.

At the time of my last visit (June 13), about 100 linear feet had been completed and the piling for 1,100 feet driven. I was informed that during rough weather the water on the lee side of the finished part was quite smooth, and it was believed that when it was completed the beneficial effects resulting to the wharves of the city would undoubtedly be very considerable; but there were doubts as to the sufficiency of its

length. Full security for the docks could hardly be expected unless the breakwater was extended about 5,000 feet.

This extension would have to be in water somewhat deeper than the present work, and consequently would cost probably one-half more per linear foot. The total cost for 5,000 feet additional would be $94,462.50, including contingencies.

Some interests located east of the main part of the city are of course not benefited by the breakwater as located. To give them equal protection it would be necessary to build a new pier on the line x. y., extending from the shore about 4,000 feet. Such a pier would cost $50,380, including contingencies.

Although there is deep water in the vicinity of the ore docks it is too shoal in the western portion to accommodate the shipping interests located there. Some dredging will be required in front of the dock line.

To give a channel 200 feet wide with a depth of 17 feet, about 375,000 cubic yards of material would have to be excavated. This will cost $103,125, including contingencies, providing no rock is to be removed.

Ashland is a comparatively new city and has already developed quite an extensive commerce. The principal exports are iron ore and lumber, but as some large manufacturing concerns are locating here it is probable that the variety of the articles exported will soon experience as considerable an increase as is taking place steadily in the case of the staple exports. The prospects of the place are very encouraging and the citizens are strongly of the opinion that if the tempestuous features of the beautiful bay which forms their harbor can be eliminated the city's prosperity is assured.

RÉSUMÉ OF RECOMMENDATIONS.

For 5,000 feet extension to the breakwater under construction	$94,462.50
For 4,000 feet of breakwater east of the main part of the city	50,380.00
For dredging	103,125.00
Total	247,967.50

This work is in the collection district of Superior, Mich.; nearest light-house, La Point, on Chequamagon Point, at entrance of Chequamagon Bay.

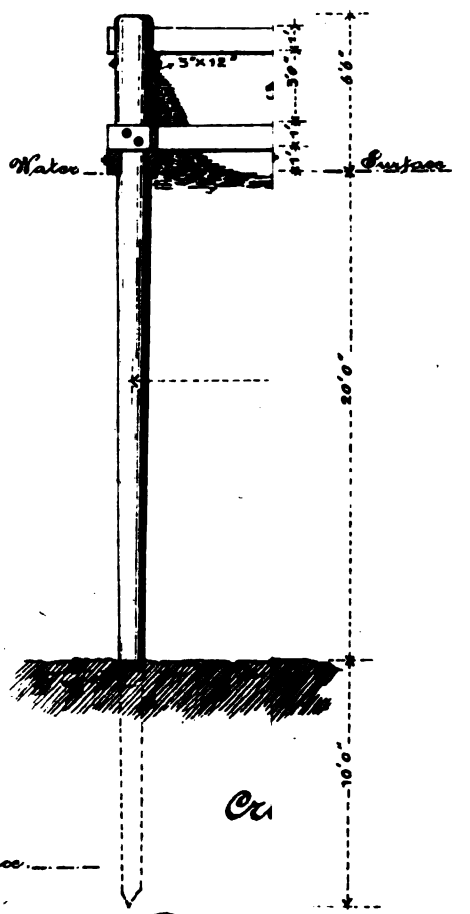
ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT ASHLAND, WISCONSIN.

By act of Congress approved August 5, 1886	$22,500
By act of Congress passed August 11, 1888	60,000
Total	82,500

Money statement.

July 1, 1888, amount available		$20,993.03
Amount appropriated by act of August 11, 1888		60,000.00
		80,993.03
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$1,050.84	
July 1, 1889, outstanding liabilities	6,477.00	
July 1, 1889, amount covered by existing contracts	47,288.50	
		54,816.34
July 1, 1889, balance available		26,176.69
Amount (estimated) required for completion of proposed project		247,967.50
Amount that can be profitably expended in fiscal year ending June 30, 1891		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

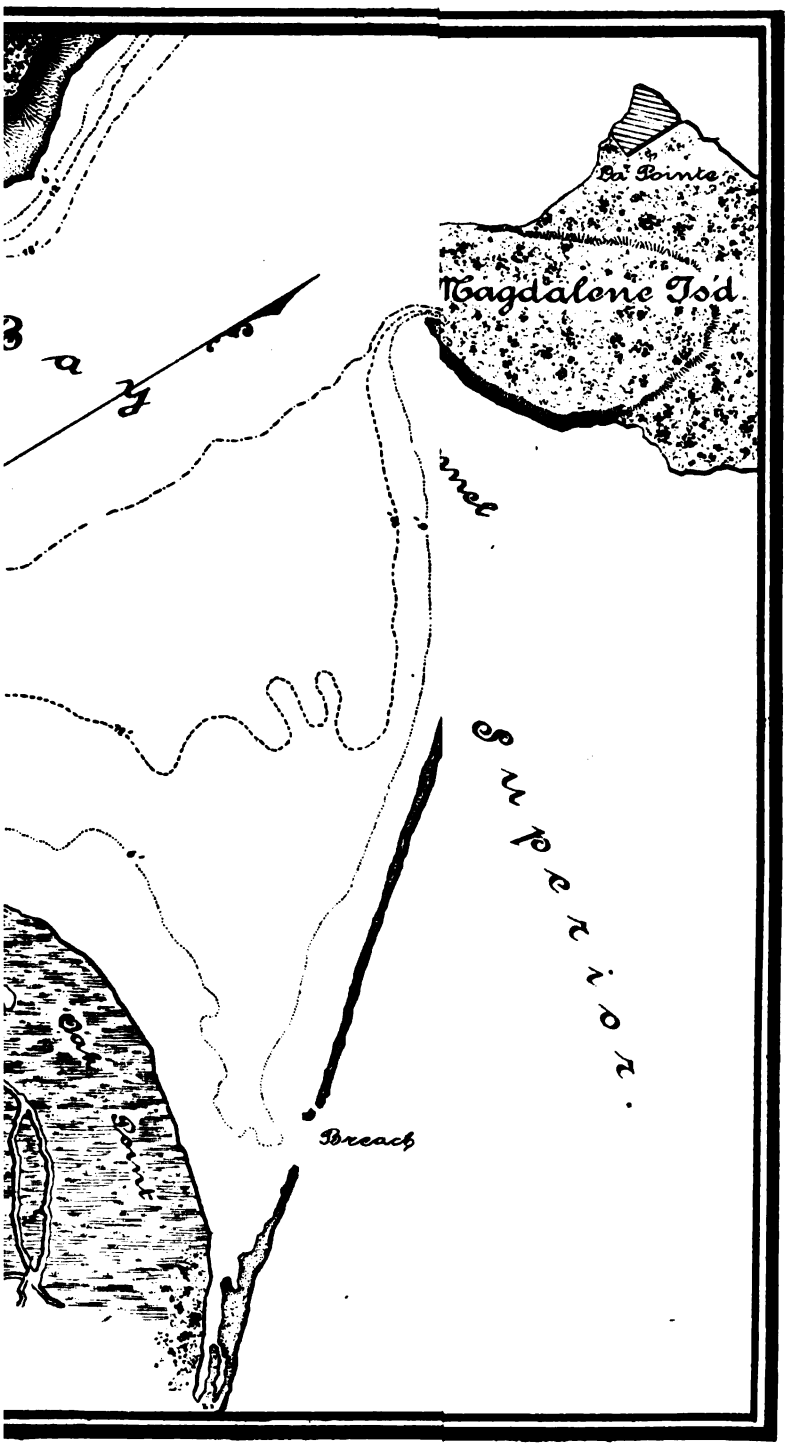


Plan:
at Oschpc.

To accompany annual June 30 1889.

S. U. S. A.

50 feet.


La Pointe
Magdalene Isd.
Breach
Point

Abstract of proposals received for constructing 3,861 linear feet, more or less, of breakwater at Ashland, Wis.

[Opened April 5, 1889, at Duluth, Minn., by Maj. James B, Quinn, Corps of Engineers.]

No.	Name and address of bidder.	Prices bid for breakwater, per running foot, complete.	Total.
1	Hiers B. Herr & Co., Chicago, Ill	$19.90	$76,833.90
2	Truman & Cooper, Manitowoc, Wis	26.00	100,386.00
3	Huston & Mitchell, Ludington, Mich	16.20	62,548.20
4	Nelson C. Chapman, Minneapolis, Minn	18.20	70,270.20
5	Schwarz & Berner, Green Bay, Wis	16.89	65,212.29
6	Zimmerman & Sang, Duluth, Minn	15.24	58,841.64
7	Lyman I. Burbank, Ashland, Wis	16.72	64,555.92
8	Sherwood, Sutherland & Oakes, St. Paul, Minn	17.70	68,339.70
9	Henry F. Balch, Minneopolis Minn	16.70	64,478.70
10	Morrison, McGregor & Hannah, Duluth, Minn	16.81	64,903.41
11	Dear & Hayes, Duluth, Minn	18.78	72,509.58
12	Wolf & Trnax, Duluth, Minn	17.25	66,602.25
13	McCue & Ennis, Duluth, Minn	18.67	72,084.87
14	Hugh Steele, Duluth, Minn	11.45	44,208.45
15	Thomas Dwyer, Duluth, Minn	14.63	56,486.43
16	Powell & Mitchell, Marquette, Mich	14.78	56,872.52
17	Barker & Matthews, Duluth, Minn	16.00	61,776.00

Contract awarded to Hugh Steele as the lowest bidder for constructing 4,650 linear feet of breakwater, with the approval of the Chief of Engineers. Contract dated April 26, 1889; work to be completed by October 31, 1889.

COMMERCIAL STATISTICS.

[Furnished by C. H. Call, collector of customs.]

Arrivals and clearances of vessels.

Year.	Arrivals.	Tonnage.	Clearances.	Tonnage.	Vessels.
1887	446	325,172	* 446	325,172	892
1888	473	346,180	473	346,180	*946

* The arrivals and clearances show only vessels reporting at, and clearing from, custom-house at Ashland, and does not include the large number of vessels calling at this port which are destined for Duluth and Superior.

Principal articles of export and import.

Articles.	Approximate value, 1887.	Approximate value, 1888.
EXPORTS.		
Iron ore	$6,244,380	$6,063,360
Lumber	1,210,090	1,200,000
Total	7,454,470	7,263,360
IMPORTS.		
Coal	750,000	780,000
Railroad iron	90,800	87,900
Brownstone	150,000	143,000
Oil	140,000	120,900
Cement, lime, and brick	75,450	68,000
General merchandise	1,850,000	1,560,870
Miscellaneous	560,760	700,000
Total	3,617,010	3,460,670

H H 6.

IMPROVEMENT OF HARBOR AT ONTONAGON, MICHIGAN.

The project to give a navigable depth of 12 feet into the Ontonagon River was adopted in 1867. In accordance with this project two piers have been constructed on either side of the river's mouth projecting into the lake.

The east pier is now 2,315 feet in length, and the west pier 2,525 feet in length. The inner ends of these piers are of piling, which is in a very bad condition through decay and the erosion of the ice, and will require almost complete renewal or substitution by better style of work in a very short time.

At the end of this season's work the west pier will have been extended 150 feet by the addition of 3 more cribs, and superstructure will have been completed on the crib sunk in 1877 on the east pier. The contract for this new work was awarded to Mr. J. C. Morrison, of Duluth, Minn., under contract dated December 21, 1888.

The bar at the extremity of the piers continues to advance almost as rapidly as the advance of the piers, and the channel across it is uncertain and shifting, so that frequently the steamer *City of Fremont* has great difficulty in entering the harbor when drawing not over 10 feet of water. The principal portion of this bar is composed of the material brought down by the river in the spring, and it is likely that by dredging out the channel after the subsidence of the freshets each year would now prove as efficacious as the further lengthening of the piers.

The straight form of pier is somewhat objectionable, since the littoral currents are arrested and the sand they bear along deposited directly off the ends of the piers. In this case it does not appear that the circumstances would warrant the construction of deflecting piers for the reason that the progress of the harbor piers has reached a point where deflecting piers, to be of value, would nearly equal their original cost. It appears that, for a few years, the removal of the bar at the outer extremity by dredging would be the most economical expenditure of money for the improvement of this place. This would require the removal of at least 60,000 cubic yards of material each year at a cost of about $15,000.

The replacing of the 780 feet of pile-pier with a slab and pile pier, after the model of the Ashland breakwater, would cost $15,600.

RECOMMENDATIONS FOR NEXT YEAR.

For dredging	$15,000
For 780 feet of slab and pile pier	15,600
Total	30,600

This work is in the collection district of Superior, Mich.; nearest port of entry, Marquette, Mich. A light is shown on the outer end of the west pier at Ontonagon, Mich

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT ONTONAGON, MICH.

By act of Congress approved—

March 2, 1867	$97,600
July 11, 1870	10,000
June 23, 1874	23,000
March 3, 1875	25,000
August 14, 1876	15,000
June 18, 1878	15,000

By act of Congress approved—	
March 3, 1879	$17,000
June 14, 1880	15,000
March 3, 1881	20,000
By act of Congress passed August 2, 1882	20,000
By act of Congress approved—	
July 5, 1884	15,000
August 5, 1886	13,000
By act of Congress passed August 11, 1888	12,500
Total	298,100

EXPENDITURES.

Amount expended under approved project to June 30, 1889	$284,903.74
Amount covered by existing contracts	10,640.00
Balance available July 1, 1889	2,556.26
	298,100.00
Estimated amount required annually for preserving and maintaining (dredging)	15,000.00

Money statement.

July 1, 1888, amount available		$1,541.98
Amount appropriated by act of August 11, 1888		12,500.00
		14,041.98
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$680.72	
July 1, 1889, outstanding liabilities	165.00	
July 1, 1889, amount covered by existing contracts	10,640.00	
		11,485.72
July 1, 1889, balance available		2,556.26
Amount (estimated) required for completion of existing project		65,670.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		30,600.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received for constructing 150 linear feet of substructure and 200 linear feet of superstructure on harbor piers at Ontonagon, Mich.

[Opened November 22, 1888, at Duluth, Minn., by Maj. James B. Quinn, Corps of Engineers.]

No.	Name and address of bidder.	Substructure, 20 feet wide, per running foot.	Superstructure, 20 feet wide, per running foot.	Total
1	Nelson C. Chapman, Minneapolis, Minn	$66.50	$16.60	$13,295
2	*John H. Gillett, Marquette, Mich			
3	J. C. Morrison, Duluth, Minn	56.00	11.20	10,640
4	Charles Berner, Green Bay, Wis	60.00	20.00	13,000

* Informal, no bid having been submitted for the work as required.

Contract awarded to J. C. Morrison, the lowest bidder, with the approval of the Chief of Engineers. Contract dated December 21, 1888; work to be completed by September 30, 1889.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels.

Year.	Arrivals.	Departures.	Tonnage.
1887	174	174	222,000
1888	120	120	188,100

Principal articles of export and import.

Articles.	Approximate value, 1887.	Approximate value, 1888.
EXPORTS.		
Lumber	$270,000	$400,000
Copper	40,000	48,000
Fish	14,000	1,150
General merchandise	20,000	9,850
Total	344,000	458,000
IMPORTS.		
General merchandise	160,000	166,500
Grain	12,000	.....
Flour	9,000	.....
Meats	6,700	.....
Salt	500	.....
Coal	1,500	3,150
Live stock	.....	3,210
Dressed lumber	.....	430
Total	189,700	173,288

H H 7.

IMPROVEMENT OF EAGLE HARBOR, MICHIGAN.

This work was transferred to me September 4, 1888, by Maj. Charles E. L. B. Davis, Corps of Engineers.

Since the completion of the channel through the reef in 1877 and the erection of the guide-piers in 1879, nothing in the way of improvement at this place has been attempted.

The work is in a fairly good state of preservation.

Modified estimate (see Report of Chief of Engineers, 1876, II, 328; 1877, I, 98; II, 845)	$97,000
Appropriated	97,000

Money statement.

July 1, 1888, amount available	$2,486.33
July 1, 1889, balance available	2,486.33

COMMERCIAL STATISTICS.

Name of harbor, Eagle Harbor, Michigan; collection district, Superior, Mich.; nearest light-house, Eagle Harbor, Mich.

Not having been able to obtain commercial statistics for the calendar year, 1888, I append those for the calendar year, 1886.

	Approximate value.
Exports:	
Copper	$450,000
Imports:	
Coal	45,000
Lumber	8,000
Total	53,000

Amount of revenue *collected*, none.

H H 8.

IMPROVEMENT OF HARBOR AT MARQUETTE, MICHIGAN.

This work was transferred to me September 4, 1888, by Maj. Charles E. L. B. Davis, Corps of Engineers.

The breakwater projected in 1866 for this harbor was completed in 1875. It is 2,010 feet long and consists of timber cribs filled with stones. The superstructure is somewhat decayed and will need slight repairs, but, generally considered, the work is in very good condition. About $5,000 will be required annually to keep it in repair.

The area available for secure anchorage was never very large, and by the encroachment of docks was being gradually reduced till the condition of affairs attained such a state as to necessitate the interference of the Government.

Pursuant to section 12 of the river and harbor act of August 11, 1888, a harbor line was established and the money appropriated for the extension of the breakwater became available. Bids were invited and opened June 12, 1889, and Morrison & Hannah, of Duluth, Minn., being the lowest bidders, were awarded the contract for constructing 180 linear feet of pier. This extension differs in plan somewhat from the portion hitherto constructed. It consists of a riprap foundation supporting the cribs, essentially after the plan adopted for the breakwater at Milwaukee, Wis., or, briefly, it will consist of three cribs, each 60 feet long, 24 feet wide, and 18½ feet high, standing on a stone embankment, and a continuous superstructure 180 feet long, 24 feet wide, and 6 feet high. The average depth of water is 32 feet. Work is to commence not later than July 1, 1889.

The importance of Marquette Harbor, both as a shipping port and harbor of refuge, and the present limited safe anchorage area makes it urgently necessary to extend the breakwater at least 1,000 feet to the southward. At present rates this would cost $121,000, including contingencies.

Original estimate (see Report of Chief of Engineers, 1866, III, 8; IV, 81)	$385,129.58
Appropriated	354,230.00
Estimated amount required annually for preserving and maintaining (see annual report of Maj. Charles E. L. B. Davis for 1888)	4,200.00

This work is in the collection district of Superior, Mich.; nearest light-house, Marquette, Mich.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT MARQUETTE, MICH.

By act of Congress approved—	
March 2, 1867 (allotment)	$85,000
April 10, 1869 (allotment)	26,730
July 11, 1870	25,000
March 3, 1871	60,000
June 10, 1872	50,000
March 3, 1873	15,000
June 23, 1874	15,000
March 3, 1875	15,000
August 14, 1876	2,000
June 18, 1878	2,000
March 3, 1879	1,500
June 14, 1880	1,000
By act of Congress passed August 2, 1882	16,000
By act of Congress approved—	
July 5, 1884	5,000
August 5, 1886	10,000
By act of Congress August 11, 1888	25,000
Total	$354,230

Money statement.

July 1, 1888, amount available		$9,000.86
Amount appropriated by act of August 11, 1888		25,000.00
		34,000.86
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$1,346.77	
July 1, 1889, outstanding liabilities	65.49	
July 1, 1889, amount covered by existing contracts	19,800.00	
		21,212.26
July 1, 1889, balance available		12,788.60
Amount (estimated) required for completion of proposed project		121,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		121,000.00

Abstract of proposals received for constructing 180 linear feet of breakwater at Marquette, Mich.

[Opened June 12, 1889, at Duluth, Minn., by James B. Quinn, Corps of Engineers.]

No.	Name and address of bidder.	Substructure, 24 feet wide, per running foot.	Superstructure, 24 feet wide, per running foot.	Total.
1	John Munro, jr., St. Ignace, Mich.*			
2	Powell & Mitchell, Marquette, Mich	$120.42	$19.74	$25,228.80
3	Morrison & Hannah, Duluth, Minn	92.90	17.10	19,800.00

*Informal; no bid having been submitted for the work as required.

Contract awarded to Morrison & Hannah, the lowest bidders, with the approval of the Chief of Engineers.

Contract dated June 25, 1889; work to be commenced by July 1, 1889, and completed by November 15, 1889.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels.

Year.	Arrivals.	Clearances.	Tonnage.
1887	695	695	539,572
1888	654	654	547,000

Principal articles of export and import.

Articles.	Approximate value, 1887.	Approximate value, 1888.
EXPORTS.		
Iron ore	$5,369,784	$5,912,858
Pig-iron	175,000	222,612
Lumber, laths, and shingles	263,784	214,354
Machinery	250,000	.....
Brownstone, powder, etc	185,000	110,141
Miscellaneous	105,000	8,021
Total	6,348,568	6,467,986
IMPORTS.		
Coal	569,000	725,490
Flour and feed	20,600	46,080
Machinery	165,100	.....
Miscellaneous	400,760	122,590
Oil and provisions	95,280	169,000
Brick, iron rails, etc	50,987	83,314
Nitrate of soda	.....	132,000
Acid	.....	225,000
Total	1,301,727	1,503,474

Amount of revenue collected in 1887, $11,110.83.

H H 9.

IMPROVEMENT OF HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN.

The bay of Grand Marais, Mich., is about half way between White Fish Bay and Grand Island, and on a part of the coast which is perhaps exposed to as violent storms as ever visit Lake Superior. The many wrecks which line the shore in the immediate vicinity of this bay are mute witnesses of the importance for the speedy completion of the harbor of refuge projected for this place.

The natural entry has but little depth of water, and under the effect of varying storms possesses no stable channel. The bay is of ample depth and size to afford shelter for a large fleet.

The object of the work at this place is therefore to provide a permanent entrance to the bay of sufficient depth and width to accommodate the commerce of Lake Superior passing to and fro and in its vicinity. The accompanying map will give an idea of the condition of the work.

The superstructures are being placed upon the cribs unprovided with them, and a channel is being dredged out between the piers. It is hoped that this work will be in such condition at the end of the season that it will not suffer much depreciation. The necessity for the speedy completion of the entire work as a measure of economy is, I think, obvious.

The shore sand drifts badly under the action of the wind, and it will be necessary to construct sand fences on either side of the entry to arrest this. Furthermore, I am apprehensive that when the cut through is made the reverse swells will abrade the banks at the inner ends of the piers, and cause a serious filling up of the channel if it does not work out a breach around the piers through which the sand will be carried in a storm and cause a refilling of the dredged channel. I think

it is essential that a revetment of sheet-piling on the lines indicated on the map should be constructed at the earliest opportunity. This sheet-piling revetment will cost $4,719, including contingencies.

The sand-fences, consisting of a double row of posts and boards filled in with brush and weighted with stone after the plan pursued successfully at Provincetown, Cape Cod, Mass., would cost $1,000, including contingencies.

I do not think that this additional work will add anything to the original estimates, since the contingency estimate has not been approached owing to the exceeding good fortune which has attended the work so far.

One of the cribs which was originally carried away from the west pier by a storm in 1886 lies stranded and filled with sand between the piers and will have to be removed. It is not particularly in the way at present but will be shortly. Its recovery will probably be rather an expensive affair and it may prove most economical to break it up. No proposition concerning its removal has been received yet, although the contractor doing the dredging has been asked for an estimate.

It is important that the piers be completed as projected before the dredging is finished, but the need of a harbor at this place is so urgent that the effort to obtain a channel of some kind has warranted the commencement of dredging, though it is hardly possible that a very useful channel can be secured this season. No serious accession to the material between the piers is to be apprehended if the prolongation of the piers continues with reasonable celerity. It would be conducive of great economy if the whole of the amount ($268,750) necessary to complete the work could be made available so as to permit an early resumption of work next season. I believe that the whole of this sum ($268,750) could be most advantageously expended in 1890 owing to the improved facilities and methods of construction at present available.

The amount expended to the close of the year ending June 30, 1889, was $144,059.47, and has resulted in the extension of the west pier by crib-work 200 feet in length, and the building of 400 feet of superstructure 20 feet wide, 6 feet high.

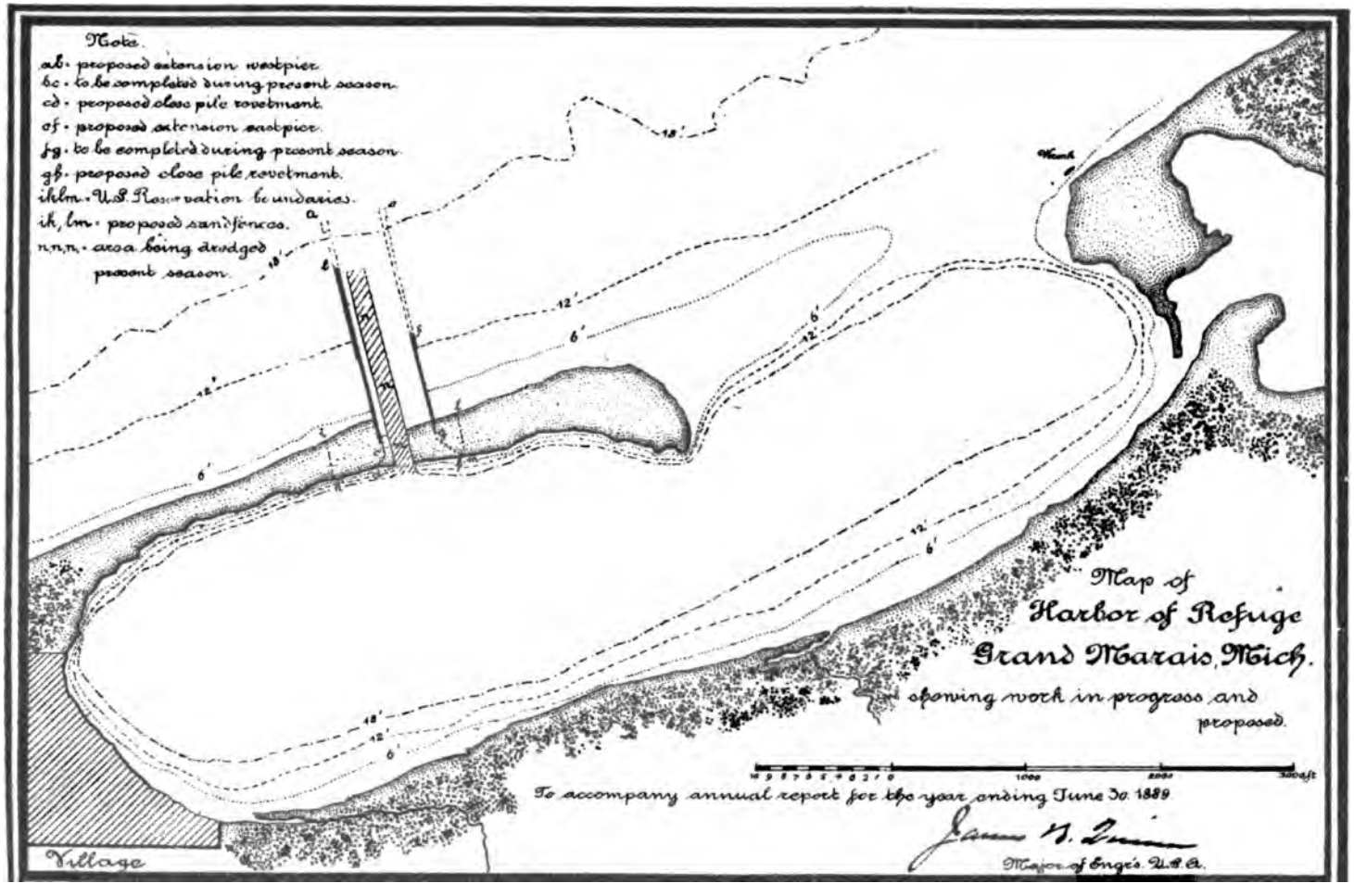
By September 30, 1889, the remainder of the piers unprovided with superstructures (1,200 feet) will have been completed, 650 feet on the west pier and 550 feet on the east pier, and a channel 150 feet wide and 17 feet deep will have been dredged. Amount of material excavated to June 30, 1889, was 27,171.4 cubic yards.

Original estimate (see Report of Chief of Engineers, 1881, page 2053)	$450,000
Appropriated	181,250

This work is in the collection district of Superior, Mich. Nearest light-house, Big Sable, Michigan.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN.

By act of Congress—	
Approved June 14, 1880	$10,000
Approved March 3, 1881	20,000
Passed August 2, 1882	40,000
Approved July 5, 1884	35,000
Approved August 5, 1886	26,250
Of August 11, 1888	50,000
	181,250


Note.
ab. proposed extension westpier.
bc. to be completed during present season.
cd. proposed close pile revetment.
ef. proposed extension eastpier.
fg. to be completed during present season.
gh. proposed close pile revetment.
ihklm. U.S. Reservation boundaries.
ik, lm. proposed sand fences.
n,n,n. area being dredged present season.
Map of
Harbor of Refuge
Grand Marais, Mich.
showing work in progress and proposed.
To accompany annual report for the year ending June 30. 1889
Major of Engrs. U.S.A.
Village

Money statement.

July 1, 1888, amount available		$1,839.55
Amount appropriated by act of August 11, 1888		50,000.00
		51,839.55
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$1,825.10	
July 1, 1889, outstanding liabilities	12,823.92	
July 1, 1889, amount covered by existing contracts	32,361.56	
		47,010.58
July 1, 1889, balance available		4,828.97

Amount (estimated) required for completion of existing project	268,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	268,750.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received for building superstructures and dredging between harbor piers at Grand Marais, Mich.

[Opened November 24, 1888, at Duluth, Minn., by Maj. James B. Quinn, Corps of Engineers.]

No.	Name and address of bidder.	Superstructure, 24 feet wide, 6 feet high, per running foot.	Superstructure, 20 feet wide, 6 feet high, per running foot.	Superstructure, 24 feet wide, 3 feet high, per running foot.	Superstructure, 20 feet wide, 3 feet high, per running foot.	Total for building 1,600 linear feet of superstructure.	Dredging, prices bid per cubic yard.
							Cents.
1	Nelson C. Chapman, Minneapolis, Minn	$19.25	$18.50	$12.00	$11.00	$26,012.50	.....
2	John H. Gillett, Marquette, Mich*	.....	.....	.....	.....	.....	.....
3	Hagen & English, Green Bay, Wis.	21.10	17.25	12.50	8.90	25,000.00	.....
4	Truman & Cooper, Manitowoc, Wis	20.00	19.00	10.00	9.00	25 000.00	.....
5	Charles Berner, Green Bay, Wis	24.00	22.00	12.00	12.00	31,000.00	.....
6	Powell & Mitchell, Marquette, Mich	19.62	18.17	10.34	8.78	24,928.00	.....
7	M. H. Fitzpatrick, Duluth, Minn	23.00	19.00	13.00	10.00	28,200.00	19½
8	Williams, Upham & Co., Duluth, Minn	.....	.....	.....	.....	.....	22
9	Charles S. Barker, Duluth, Minn	.....	.....	.....	.....	.....	20

* Informal; no bid having been submitted for the work as required.

Contract for building 1,600 linear feet of superstructure awarded to Powell & Mitchell, the lowest bidders, with the approval of the Chief of Engineers. Contract dated January 2, 1889; work to be completed by September 30, 1889.

Contract for dredging between harbor piers awarded to M. H. Fitzpatrick, the lowest bidder, with the approval of the Chief of Engineers. Contract dated December 27, 1888; work to be completed by September 30, 1889.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels.

Year.	Arrivals.	Tonnage.	Clearances.	Tonnage.
1887	38	5,825	36	5,025
1888	81	12,500	81	12,500

Principal articles of export and import.

Articles.	Approximate value, 1887.	Approximate value, 1888.
EXPORTS.		
Wood	$500	$1,000
Fish	1,000	5,000
Farm produce	100	.....
Lumber	.....	20,000
Total	1,600	26,000
IMPORTS.		
Lumber	6,200	.....
Iron (manufactured)	1,000	.....
Hay and grain	5,000	5,000
General merchandise	5,000	20,000
Stone	500	12,000
Total	17,700	37,000

H H 10.

PRELIMINARY EXAMINATION OF BLACK RIVER, LAKE SUPERIOR, MICHIGAN, TO DEEPEN CHANNEL TO DEPTH OF SIXTEEN FEET AND CONSTRUCTING A BREAKWATER.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., October 12, 1888.

GENERAL: In pursuance with instructions contained in letter from your office dated September 29, 1888, I have the honor to report that I visited the mouth of Black River, Michigan, and made a personal examination.

At the time of our visit the river, where it debouches into the lake, had a width of about 15 feet and a depth of about 18 inches. Off the mouth, at a distance of about 400 feet from the shore, the water was from 3½ to 4 feet deep, and it was fully 700 feet from the shore to 15 feet depth.

Above the mouth there is a small bay about 400 feet long and 150 feet wide, with an average depth of about 7 or 8 feet. At no place did there exist a greater depth than 12 feet.

The bluffs on either side of the river are of sandstone, and the bottom of the river, where it could be seen, is of the same material. Rapids begin about one-fourth mile from the mouth and extend to a point probably one-half mile from the mouth, at which point the water has a sheer fall of about 50 feet. There are no visible industries upon the river which would be benefited by its improvement.

The cost of creating a harbor here of sufficient size to accommodate two or three vessels at the same time would be far beyond any benefits which prospective commerce at this place would warrant. In fact, I have so far been unable to obtain any information as to what interests would be benefited by the proposed improvement of this river, and I am consequently inclined to believe that there are none of importance.

The cost of parallel piers in the lake, and the dredging between them to give 16 feet depth of water to the small basin inside would be not less than $387,000, and the excavation required within the basin to give an area not over 400 by 200 feet and 16 feet deep, would easily bring this up to $500,000.

For above reasons I do not think Black River, Michigan, is worthy of improvement.

Very respectfully, your obedient servant,

JAMES B. QUINN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

H H 11.

ESTABLISHMENT AND MAINTENANCE OF HARBOR LINES IN PORTAGE LAKE, MICHIGAN.

I am not in receipt of any information at present regarding the outcome of the application of the United States attorney for western Michigan for an injunction restraining the mill-owners from dumping débris into Portage Lake between the harbor lines established by the Secretary of War.

If any filling up of the lake has taken place since the time of the last survey its extent could only be determined by a resurvey, and I am not aware that there are any funds available for this purpose.

At the time of my visit to this locality last fall the mills were still in operation, and while it is probable that the coarse particles of the refuse were boated away and deposited in unprohibited locations, the muddy appearance of the water indicated that it held in suspension much fine matter which would be slowly deposited in quiet water, and cause a general shoaling in Portage Lake and the canals connecting it with Lake Superior.

This charge was transferred to me September 4, 1888, by Maj. Charles E. L. B. Davis, Corps of Engineers, to whose report for 1888 attention is respectfully invited.

H H 12.

ESTABLISHMENT OF HARBOR LINES AT MARQUETTE HARBOR, MICHIGAN.

MARQUETTE, MICH., *September* 3, 1888.

DEAR SIR: Have you on record a plat showing the harbor lines as established last winter by our city council? If so, are the lines satisfactory as established?

Yours, truly,

F. B. SPEAR.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS TO MR. F. B. SPEAR.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., September 17, 1888.

SIR: Your letter of the 3d instant, asking if the plat of the harbor lines as established by city council at Marquette Harbor, Michigan, is satisfactory to this office, has been received.

In reply I have to say that the lines proposed by the city council are not satisfactory.

Under the provisions of the river and harbor act of August 11, 1888, steps may be taken for the establishment of harbor lines at Marquette Harbor.

Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers,
In charge.

Mr. F. B. SPEAR,
Marquette, Mich.

LETTER OF MR. F. B. SPEAR TO THE CHIEF OF ENGINEERS.

MARQUETTE, MICH., *September* 20, 1888.

DEAR SIR: Last winter, before the council took action in establishing harbor lines, the proposed line was submitted to the Department, I understood, and was accepted and so passed.

May I trouble you for information that may enable the city to correct or establish lines in accordance with your views?

Yours truly,

F. B. SPEAR.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 27, 1888.

Respectfully referred to Maj. J. B. Quinn, Corps of Engineers, for report.

Letter of 3d instant from Mr. Spear, and press copy of reply thereto from this office of September 17, are herewith.

All the papers to be returned.

By command of Brig. Gen. Casey.

JAS. C. POST,
Major of Engineers.

[Second indorsement.]

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., November 3, 1888.

Respectfully returned to the Chief of Engineers, U. S. Army, with report herewith.

JAMES B. QUINN,
Major of Engineers.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., November 3, 1888.

GENERAL: I have the honor to report as follows upon the letter of Mr. F. B. Spear, of Marquette, Mich.

At the time the breakwater was commenced there was nothing known of the "Grace furnace wharf" or the "saw-mill dock." These docks have grown under the protection of the United States breakwater until they have absorbed a large area which it was originally believed would be preserved as a safe anchorage area.

The saw-mill company is, apparently, not entirely satisfied with their monopoly of a large portion of the protection afforded by the breakwater for wharfage purposes, but have so filled up the remainder of the protected space with rafts, etc., that the purpose for which the breakwater was built is greatly interfered with. Some idea of the present condition of affairs may be inferred from the letter of the collector of customs to Maj. C. E. L. B. Davis, Corps of Engineers, Major Davis' indorsement thereon, and a tracing of the harbor of Marquette herewith.

Lieut. Col. J. W. Barlow, Corps of Engineers, in a communication to the mayor of Marquette, on February 11, 1886, invited his attention to the encroachment upon the sheltered portion of the harbor of Marquette, and advised the early establishment by the city council of suitable harbor lines; that even these wharves had been built out beyond what should have been the established harbor line, so that the breakwater did not afford protection to so large an anchorage area as was intended.

On August 5, 1886, Mr. George L. Burtis addressed a letter to Lieutenant-Colonel Barlow, of which the following is an extract:

* * * * * * *

I desire to extend my lumber dock 200 feet farther out into the harbor, to meet the imperative needs of the lumber business of this place.

I am sure I can show you that such an extension will not impair the usefulness of the harbor.

If no line has been established, am I free to go ahead and extend my dock; if not, to whom should I apply for permission? Other docks here are 700 to 800 feet farther out than I am.

The reply to this was made by Capt. C. E. L. B. Davis, Corps of Engineers, August 7, 1886, he having succeeded Lieutenant-Colonel Barlow in the charge of this work, of which the following is an extract:

* * * * * * *

The river and harbor bill just passed by Congress contains a clause prohibiting the impairment in any manner of the usefulness of any work built by the United States for the improvement of any of its navigable waters.

There being no established dock-line, I can not advise you as to extending your dock further than to call your attention to the above, mentioned law, and to say that no encroachment on the usefulness of the harbor will be permitted.

Mr. Burtis replied to this that he was confident that it could be shown that his proposed dock extension would not impair the usefulness of the breakwater, but rather extend the commerce which it protected, and asked what further action was required to bring this matter to a conclusion.

Captain Davis made no reply to this, and on the 4th of September Mr. Burtis wrote to him as follows:

I wrote you some time since inquiring to whom I must apply for permission to make an extension of my dock 200 feet farther out from shore. Not having heard from you, I fear my letter may not have reached you, so again make the inquiry.

To this Captain Davis replied as follows:

Your letter of 4th is received.

The local authorities at Marquette ought to have established the harbor-lines, but I believe they have never done so.

Your application should be made to them.

On September 4, 1886, the common council of Marquette passed an ordinance establishing a dock line, which line, I believe, was subsequently disapproved by the Chief of Engineers.

Pending the settlement of this question it appears that Mr. George L. Burtis must have applied to the local authorities of Marquette for permission to build the extension to his dock, for, in the ordinance of the city of Marquette of March 3, 1888, adopting a dock-line, the outer face of his dock built in 1887 is on this line.

I infer, therefore, that inasmuch as the city had granted him permission to extend his dock, it did not wish to accept the consequences of re-

quiring him to remove it, and therefore made an advance in the dock-line which practically encroaches upon the safe anchorage area of the harbor.

During a northeasterly storm the swells which enter the harbor around the end of the breakwater produce such a disturbance at the ore docks that all vessels lying alongside of these docks are obliged to pull out and seek shelter close under the lee of the breakwater.

Whatever encroaches upon this safe anchorage area obviously impairs the usefulness of the breakwater for the purpose for which it was built; the benefit of the general public.

Mr. Burtis's dock and log-boom clearly trespass upon this valuable space, and I think the complaint of Mr. Call would be sufficient to base an action upon, on behalf of the United States, to have these obstructions removed. I think Mr. Call can obtain whatever affidavits may be necessary to commence the suit. The removal of this dock would enable the city authorities to locate a dock-line in some such position as that indicated upon the accompanying tracing by the lines E, F, G, H, I, K.

This would still leave Mr. Burtis a very large portion of the breakwater cover for his almost exclusive benefit, and would limit the farther advance of the ore docks.

Iron ore is the principal product shipped from Marquette; the docks for handling this material are very expensive structures, for the reason that they are very lofty and require to be built very substantially; the shore is rocky, and the approaches are, consequently, difficult to construct.

These docks are necessarily of great length, in order to provide storage room for the ore and to accommodate and facilitate the loading of vessels, which unfortunately, by force of circumstances, are unable to regulate precisely the dates of their arrivals and departures, and often many arrive on the same day.

Their location is such that they can hardly be said to receive much protection from the Government breakwater, for, as formerly stated, vessels moored at these are obliged in stormy weather to haul off and seek anchorage under the lee of the breakwater.

If the shipping moored at these docks was thoroughly secure from the effects of storms, the necessity for preserving the largest possible area for secure anchorage under the lee of the breakwater would not exist. Mr. Burtis's dock extension, log-booms, and rafts might even be tolerated so long as they did not interfere with the reasonably free movement of vessels about the docks, and even a considerably greater extension of the ore docks might be permissible, for I believe that the object of the Government improvement is not so much the providing of a harbor of refuge as it is a safe harbor for the convenience of the local commerce, compared with which the commerce which seeks shelter in Marquette Harbor during stress of weather is insignificant, and it does not therefore appear reasonable that the latter should receive every consideration.

There should be some satisfactory compromise, and it appears to me that with the establishing of the dock-lines proposed and the extension of the breakwater until the ore docks as built are protected, the interests of the general and local commerce will be satisfactorily conserved.

Very respectfully, your obedient servant,

JAMES B. QUINN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS TO THE SECRETARY OF WAR.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., November 15, 1888.

SIR: It being manifest from the within papers that the establishment of harbor lines is essential to the preservation and protection of the harbor at Marquette, Mich., I have the honor to recommend that their establishment be undertaken in accordance with the provisions of section 12 of the river and harbor act of August 11, 1888, and that the subject be referred to a Board to consist of the following named officers of the Corps of Engineers, viz., Maj. Charles J. Allen, Maj. Charles E. L. B. Davis, Maj. James B. Quinn, the Board to meet at Marquette, Mich., upon the call of the president, at such time as the other duties of the members will permit. * * *

With the sanction of the Secretary, the order convening the Board will be issued from this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

[First indorsement.]

WAR DEPARTMENT, *November* 17, 1888.

Approved.
By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

LETTER OF THE CHIEF OF ENGINEERS TO MAJOR CHAS. J. ALLEN, CORPS OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., November 19, 1888.

MAJOR: It is desired that the Board of Engineers, constituted by paragraph 1, Special Orders No. 64, Headquarters Corps of Engineers, current series, of which you are the president, give the subject committed to it the full consideration its importance requires, in order that in carrying out its work the requirements of navigation and the protection of commerce may be fully provided for.

The Board is authorized to call upon Maj. James B. Quinn, Corps of Engineers, for any information, in addition to that already at hand, which may be required for a proper consideration of the subject.

* * * * * * *

By command of Brig. Gen. Casey.

Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers.

Major CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

REPORT OF THE BOARD OF ENGINEERS.

JANUARY, 12, 1889.

GENERAL: The Board of Officers of the Corps of Engineers, constituted by paragraph 1, Special Orders No. 64, Headquarters Corps of Engineers, Washington, D. C., November 19, 1888, to establish the harbor lines in Marquette Harbor, Michigan, in accordance with section 12 of the river and harbor act of August 11, 1888, has the honor to submit the following report:

The Board assembled at Marquette on the 27th of November and, after considering the letter of instructions of November 19, 1888, and its inclosures, from the Office of the Chief of Engineers, proceeded to an inspection of the harbor. Members of the Board also called upon a number of persons in Marquette who were in position to be informed as to the commercial necessities of the harbor, and, among them, the mayor of the city and the collector of the port.

The harbor is described by Col. D. C. Houston, Corps of Engineers (page 331, Part II, Annual Report of the Chief of Engineers for 1876), as follows:

This harbor is situated upon the south shore of Lake Superior at a distance of about 150 miles to the westward of the canal at the Sault Ste. Marie, and about 110 miles to the westward of Whitefish Point, which is the eastern extremity of Lake Superior proper. The natural harbor, which is situated between the south end of Grand Island and the main shore of the State of Michigan, is the only other place between Whitefish Point and Marquette which affords shelter to vessels.

Previous to the construction of the breakwater at this point by the United States Government, great inconvenience, not unfrequently attended with danger, was experienced by vessels in the Bay of Marquette, as it afforded no protection against storms from the points included between northeast by north and east by south, and during the prevalence of heavy weather from these quarters it was impracticable for vessels to moor at the docks, and they were necessarily obliged to beat about in the open lake until the subsidence of a storm or run under the lee of Grand Island, which is 30 miles distant.

During the year 1865 the product of the iron mines in the vicinity of Marquette was about 400,000 tons of ore, which was chiefly dependent upon this imperfect harbor for shipment, and the question of security to vessels became one of the greatest moment to this large and rapidly growing interest.

The breakwater was begun in 1867 and completed to a length of 2,010 feet in 1875. The resulting harbor area, bounded by a line connecting the heads of the docks, by the breakwater, and by a perpendicular from the latter, at its outer end, to the dock line, was about 64 acres. Further extension of the structure was recommended as early as 1875, a recommendation concurred in by the officers in charge of the improvement since that date.

The beneficial effect of the breakwater began to be felt perceptibly as early as November, 1868, when but 610 linear feet of the structure were completed. During a severe storm which occurred during that month a number of vessels took advantage of the partial shelter afforded by the breakwater and rode out the storm in safety.

The increasing commerce of Marquette and, especially, the large shipments of ore, requiring corresponding increase of dock room and facilities, the docks of wharves have, since the commencement of work upon the breakwater, continually encroached upon the harbor area. This encroachment early received the attention of the officers in charge of the harbor improvement. Opposite page 330 of Part II, Report of the Chief of Engineers for 1876, there is a map of the harbor with a line upon it marked "limit of dock extension." This limit was recommended by Assistant Engineer W. H. Hearding, in a report made by him to Col. D. C. Houston, dated January 31, 1875, in obedience to instructions

from that officer. The limits seem to have met the approval of Colonel Houston and his successors in charge of the harbor. The lines were well chosen to maintain a large harbor area (about 64 acres) as before said, and to admit of extension of some of the exisiting docks in front of the west, or main, city front of the harbor, and of the building of new docks as required.

From 1876 to 1888 there was considerable extension of wharves into the harbor and, in addition, several new ones were built. The attention of the mayor of Marquette was called to the projected extension of ore-docks, by Lieut. Col. J. W. Barlow, Corps of Engineers, in February, 1886, and the common council of Marquette, on September 4 of that year, adopted an ordinance fixing and defining the harbor limits, these being evidently so chosen as to provide for future ore-dock and lumber-wharf extensions. The advance of dock lines, as proposed by this ordinance, would have reduced the harbor area to about 16 acres, and the breakwater protection by one-half. These limits did not meet the approval of the Engineer Department, and it does not appear that the council further urged them.

The encroachments have also been the subject of complaint by the collector of the port of Marquette and by various vessel masters and owners, and complaint by the same parties has also been made of the practice of persons engaged in the lumber business at the north end of the harbor of mooring rafts and booms of logs to the breakwater, thereby prventing vessels in the harbor from approaching the breakwater for protection. One lumber dealer built a wharf in the winter of 1883–'84, 547 feet long, parallel to the breakwater, with an L at right angles and extending to within 60 feet of the cribs, inclosing an area of about 6 acres adjacent to the shore end of the breakwater. In 1887 the same person built another dock 412 feet by 100 feet, and located 65 feet in front of the former dock, thus encroaching 165 feet further upon harbor space that could be used for anchorage by light draught vessels.

Notwithstanding the present length of the breakwater, vessels can not lie at the ore-docks during the prevalence of seas from the northeast and around to a point a little to the north of east. At such times they seek anchorage under the protection of the breakwater. The portion of the harbor that then affords safe anchorage-ground is said by some of the lake navigators to lie between the breakwater and a line drawn from its outer end to the middle of the Grace Furnace Wharf, an area of about 20 acres, and of this space fully one-third is, as stated by the same navigators, rendered absolutely useless for vessels on account of its occupation by rafts and booms of logs.

Finally, on March 3, 1888, the common council of Marquette passed an ordinance establishing a dock-line which included the extensions of the ore, lumber, and other wharves to that date, and which would reduce the available harbor area to about 46 acres, viz, an area 1,430 feet in width at the north end of the harbor, 1,870 feet in width at the entrance, and 1,210 feet long, measured parallel to the breakwater. The line is shown on Tracing No. 2, herewith, by the letters G, D, E, F.

This dock-line was not approved by the Department, which contemplated the establishing of harbor lines for Marquette under the provisions of section 12 of the river and harbor act of Congress of August 11, 1888.

A meeting of citizens of Marquette was held at the mayor's office on the evening of November 27, 1888, at which were present representatives of the railroad, ore, and lumber interests, to consider the subject of

wharf-lines and the commercial needs of the harbor. The Board, by invitation, attended the meeting.

At this meeting a communication to the Board was drawn up and signed by the citizens present, setting forth the desirability and necessity for establishing a wharf-line to include the front of the existing lumber wharf, built in 1887, at the north end of the harbor, then to turn at about a right angle and to run parallel to and 1,400 feet from the breakwater. In fact, providing for a further extension of all the wharves existing along the principal or west front of the harbor, the greatest extension of dock thus proposed being for the Detroit, Mackinac and Marquette Railroad Ore Wharf, which could thus be prolonged 870 feet. The adoption of this line (G, D, H, Tracing No. 2) would reduce the harbor area to 38½ acres.

The communication is herewith, marked Appendix A.*

The argument for such an advance of the dock front was that the shipping interests did not have one-half of the dock privileges that were then necessary, and that those interests would, in the belief of the petitioners, be doubled during the coming season of navigation.

In addition, it was represented that, to prevent further advance into the harbor of the existing ore-docks and to thus force the railroad and ore companies to multiply docks and expensive approaches in order to obtain needed facilities, instead of allowing them to prolong docks, the approaches to which were already built, would work great hardship to an industry which supplied the country at large with enormous quantities of ore.

The lumber interests also urged the necessity of an increase of wharf privileges for the benefit of the community as well as for its own needs.

A letter from Mr. George L. Burtis, dated November 27, 1888, and setting forth such necessity, is herewith, marked Appendix B.*

As the navigation interests of the lakes were not represented at the meeting at the mayor's office, it was deemed expedient, on account of the great advance of the dock-line asked for by the citizens and reduction in harbor area that would follow such advance, to afford those interests an opportunity to be heard upon the subject. As communicating with them would consume several weeks, at best, the Board adjourned November 28, to resume the subject before it after sufficient facts and expression of opinion should be obtained from vessel owners and sailing masters. Letters were accordingly addressed to several lake navigation companies, and to several experienced lake navigators, requesting from them an expression of opinion as to the effect, upon those interests, of the adoption of the line asked for by the citizens, and also of other lines proposed. With these letters were blue-print maps of the harbor, showing some of the principal lines under discussion. (Please see Appendix C.*)

The replies—see Appendixes D, E, F, G, H, K,*—generally denounced the obstruction of the harbor area by rafts or other accumulations of logs, the evil effects of which, upon navigation, are also detailed in a letter to the Board from the office of the collector of the port, dated November 27, 1888. This letter is herewith, marked Appendix L.*

Returning to Appendixes D–K,* the letters from the Lake Superior Transit Company and the Lake Carriers' Association expressed the opinion that the reduction of harbor width to 1,400 feet, as proposed by the citizens of Marquette November 27, 1888, would not curtail the anchorage-space, for the reason that the only safe anchorage, when the

* Omitted.

sea is from the northeast, is within a line from the end of the breakwater to about the point D (Tracing No. 2).

The managing owner of Wilson's Transit Line writes that they now get along with the harbor as it is, but that it would be well to restrict "anything that encroaches or takes up much of the harbor." Taking everything into consideration, he favored the adoption of a line (marked on tracing 2 in yellow) to afford along the line of the Grace Furnace Wharf, at north end of the harbor, a width of 1,736 feet, and the same width at the entrance.

Captain McDougall, of Duluth, a practical navigator of Lake Superior, was of opinion that the line just described would meet the needs of navigation, but suggested that the north line of harbor pass through the front of the outer lumber wharf (built in 1887). This north line is the line authorized by the common council of Marquette, March 3, 1888, but prolonged 300 feet westwardly.

Captain McIntyre, of Chicago, superintendent of the Lake Michigan and Lake Superior Transportation Company, in effect coincided in opinion with Captain McDougall.

Were the lake-bed at the north end of the harbor composed of dredgable material, a large anchorage area could be restored by the removal of a portion of the wharves at that end and dredging to the depth required. On page 333, Part 2, of the Annual Report of the Chief of Engineers for 1876, it is stated that tests were made in March, 1869, of the character of the material forming the lake-bed upon the line of prolongation of the breakwater, by borings. An overlying stratum of sand of from 2 to 4 feet in thickness was found upon a stratum of hardpan about 20 inches in thickness. Below this the material was sand as far as could be reached with the apparatus employed. The breakwater had, at this date, attained a length of about 760 feet.

On page 332 of the same report it is stated that the character of the lake-bed near the shore is rock, covered with a thick stratum of sand.

The Lake-Survey chart of Marquette Harbor, 1859, shows a sandy bottom for the area at and about the fronts of the Grace Furnace and lumber wharves, and also a small patch of rock. These wharves are to the west of the breakwater.

Some of the lumber wharves are built on piles which must have been driven to a depth of 5 or 6 feet, if not more, into the bed, but whether through clay or sand the Board is not informed.

To dredge to a depth of 18 to 20 feet up to the line of the Grace Furnace Wharf and along that line to the breakwater (in which case the lumber wharf built in 1887 would have to be removed) over an area on which the depth of water now averages 13 feet would require the excavation and removal of about 65,000 cubic yards of material. If the material were of sand or mud, the removal would not, probably, cost more than $10,000. If clay or hardpan underlie the sand within the depth of dredging, the cost might amount to $25,000 to $30,000, and even more. It is believed that the loss of the area at the north end of the harbor consequent upon the building of the lumber wharf in 1887, and accepting the front line of that wharf, prolonged for the north harbor limit, would be compensated by a breakwater extension of 150 feet at a probable cost of $25,000.

The shipment of ore at Marquette has been and is its greatest industry, the annual shipments having, as early as 1865, amounted to nearly 400,000 tons. During the year ending June 30, 1874, there were shipped 578,879 tons.

Statistics of the port, kindly furnished by the collector of customs at Marquette, show the following:

Arrivals and departures of vessels for 1887.

	Arrivals.	Departures.
Steam-vessels	280	280
Sail-vessels	415	415
Total	695	695

Iron ore exported, value	$5,269,724
Lumber, timber, lath, and shingles, value	263,724
Aggregate value of principal articles of export and import	7,659,265

Arrivals and departures of vessels for 1888.

	Arrivals.	Departures.
Steam-vessels	371	371
Sail-vessels	283	283
Total	654	654

Iron ore exported, tons	844,694
Lumber exported, feet, board measure	15,211,000
Number of lath and shingles imported	760,000
Number of brick imported	1,630,000
Number of barrels of merchandise imported	16,000
Total of other articles exported and imported, tons	231,100

At the meeting of citizens of Marquette, November 27, it was stated that the total yield of the mines in the district back of Marquette was not less, for the past year, than 1,500,000 tons, nearly one-half of which had to be moved by rail to a distant point for shipment by water, on account of lack of dock privileges at Marquette.

It was reported on page 334, Part 2, Annual Report of the Chief of Engineers for 1876, that it was no unusual occurrence in the season of navigation to see fifty vessels riding at anchor behind the breakwater or attached to the ore-docks and merchants' piers in this harbor at one and the same time.

Such and even a greater number of vessels may, at any time in the future, occupy the harbor and its slips at the same time, and rafts of logs to be converted into lumber must also traverse the harbor. Space, then, for the free movement of vessels, as well as for anchorage, must be considered in fixing the dock limits.

The Board, after fully considering the facts presented and the prospective commerce of Marquette, and bearing in mind the evident intent of Congress in making appropriations for Marquette Harbor, that the improvement should be primarily for the benefit of the general public by securing safety and convenience of lake navigation, is of opinion that good harbor room and sufficient width of entrance will be secured by the adoption of the line A, B, C, D, E, F, G (see tracing No. 1 herewith), affording a harbor area of 48 acres.

The slip, A B C, will separate the wharves from the breakwater; the loss of the space between the line C D and the front of the Grace Furnace Wharf, prolonged, can be compensated by an extension of the

breakwater at a cost, probably, not more than that of dredging up to the line of the Furnace and adjoining lumber wharf; a uniform width of harbor of 1,736 feet will be provided; and the line generally along the west of the harbor, as proposed, will not conflict with breakwater extension; the more southerly of the ore-docks will be given space for extension beyond the line authorized by the common council of Marquette March 3, 1888; and no hardship will inure to the lumber interests by the adoption of the line proposed by the Board. Further, as the breakwater is extended, the anchorage area will be increased.

It has been suggested that the inconvenience experienced by vessels when lying at the ore-docks during heavy weather would be considerably reduced were the spaces between the piles supporting the most southerly docks filled in with rock or other heavy material to stop waves which, after passing around the end of the breakwater, pass, though broken up, between the rows of piles.

The improvement of the harbor in the interest of navigation should not be nullified by the occupation of any part of the harbor area by rafts or booms of logs, or by any accumulation of logs. Tows of logs must undoubtedly traverse the harbor more or less, but they should do so rapidly and be immediately thereafter run into shoal water, where they will not be in the way of any vessels. They should be kept entirely away from the breakwater throughout its length. Regarding the adoption for the dock limit at the north end of the harbor of the line C D, passing through the front of the outer lumber wharf, it may be said that if the material of the lake-bed at that end of the harbor be dredgable, private parties may be encouraged to provide slips at right angles to that line. Such slips would add to the length of dock front, and vessels could lie in them with far greater safety than they could at anchor in the main harbor.

RECOMMENDATION FOR ESTABLISHING HARBOR LINES AT MARQUETTE, MICHIGAN.

The harbor lines to be the inner line (west side) of the United States Government breakwater, and a dock line as marked by the letters A, B, C, D, E, F, G, on tracing No. 1, herewith, the dock line (A, B, C, D, E, F, G) being further described, and located as follows:

Beginning at a point on the west face of the United States Government breakwater, 260 feet from the shore end thereof; thence due west 75 feet; thence in a southerly direction, parallel to the east face of the United States Government breakwater, 535 feet; thence west, 1¼ degrees north, 1,667 feet; thence due south 2,293 feet; thence south 19 degrees west, 1,660 feet; thence south 12¾ degrees east, to the east and west subdivision quarter line produced, of section 26, township 48 north, range 25 west.

Respectfully submitted.

CHAS. J. ALLEN,
Major of Engineers.
CHAS. E. L. B. DAVIS,
Major of Engineers.
JAMES B. QUINN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS TO MAJOR JAMES B. QUINN, CORPS OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 4, 1889.

MAJOR: The report of January 12, 1889, from the Board of Engineer Officers constituted by paragraph 1, Special Orders, No. 64, Headquarters Corps of Engineers, November 19, 1888, to establish the harbor lines in Marquette Harbor, Michigan, was submitted to the Secretary of War with the following indorsement—

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 25, 1889.

Respectfully submitted to the Secretary of War.

It appearing that the conclusions of the Board of Engineers Officers in the within report will best meet the convenience and safety of vessels trading to the port, it is recommended that the line herein described for adoption and also represented on the accompanying map marked No. 1, and signed by the members of the Board, be established, under authority of section 12 of the river and harbor act of August 11, 1888, as the harbor lines of Marquette Harbor, Michigan, beyond which no piers or wharves shall be built or deposits made.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

and returned with the following indorsement:

[Second indorsement.]

WAR DEPARTMENT, *January* 30, 1889.

Approved.

WM. C. ENDICOTT,
Secretary of War.

The recommendations of the Board are as follows:

RECOMMENDATION FOR ESTABLISHING HARBOR LINES AT MARQUETTE HARBOR, MICHIGAN.

The harbor lines to be the inner line (west side) of the United States Government breakwater, and a dock line as marked by the letters A, B, C, D, E, F, G on tracing No. 1, herewith, the dock line (A, B, C, D, E, F, G) being further described and located as follows:

Beginning at a point on the west face of the United States Government breakwater, 260 feet from the shore end thereof; thence due west 75 feet; thence in a southerly direction, parallel to the east face of the United States Government breakwater, 535 feet; thence west, 1¼ degrees north, 1,667 feet; thence due south 2,293 feet; thence south, 19 degrees west, 1,660 feet; thence south, 12½ degrees east, to the east and west subdivision quarter line produced, of section 26, township 48 north, range 25 west.

Respectfully submitted.

CHAS. J. ALLEN,
Major of Engineers, U. S. A.
CHAS. E. L. B. DAVIS,
Major of Engineers, U. S. A.
JAMES. B. QUINN,
Major of Engineers, U. S. A.

All of which, together with a traced copy of map No. 1, above referred to, is transmitted for your information and guidance.

These lines should, if possible, be so marked as to be readily identified by those interested, in order to prevent any encroachment thereon

through ignorance or design. You will please, therefore, submit a plan for so doing.

By the above action of the Secretary of War the appropriation of $25,000 for this harbor in the river and harbor act of August 11, 1888, becomes available.

By command of Brig. Gen. Casey:

Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers.

Maj. JAMES B. QUINN,
Corps of Engineers, U. S. A.

LETTER OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS, TO THE CHIEF OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., February 12, 1889.

GENERAL: In pursuance with instructions contained in your letter of 4th instant, I have the honor to submit the following project for marking the harbor lines of Marquette Harbor, Michigan:

PROJECT.

First. That the lines be marked by monuments upon the shore placed in range and located in position by triangulation from stations established in secure positions upon the shores of the harbor, each monument to be witnessed by two or more stakes. These monuments and witness stakes to be of 1½-inch gas-pipe, 4 feet long, with welded iron points and caps, and to be driven so that cap shall be at least 18 inches below surface of ground. Each monument to contain within it a strip of tin with description stamped upon it. Marks upon existing structures in range to be made with brass tacks and paint.

Second. Notices to be painted upon boards and nailed up on the United States breakwater at the point where the line C D intersects it, and also upon the extremity of the Marquette, Houghton and Ontonagon Railroad Ore Wharf, stating that no new dock constructions or obstructions of any kind will be permitted south of or east of line (giving description of line in each case).

Third. That the honorable mayor and council of the city of Marquette be notified of the establishment of the line, and be asked to co-operate by such ordinance and regulations as may be necessary to preserve the harbor lines, if this has not already been done.

The tracing, showing dock line and positions of the triangulation stations marked by yellow dots, and the range monuments marked with red dots, is inclosed herewith.

Fourth. The estimated cost of making the necessary triangulations, placing monuments, and posting notices, including all necessary materials, will not exceed $175.

Very respectfully, your obedient servant,

JAMES B. QUINN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Col. O. M. Poe, Corps of Engineers, U. S. A., Division Engineer, Northwest Division.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Detroit, February 15, 1889.

Respectfully forwarded to the office of the Chief of Engineers, approved and recommended.

O. M. POE,
Colonel of Engineers,
Division Engineer, Northwest Division.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 20, 1889.

Respectfully returned approved.

* * * * * * * *

By command of Brig. Gen. Casey:

JAS. C. POST,
Major of Engineers

APPENDIX I I.

IMPROVEMENT OF HARBORS ON THE WEST SHORE OF LAKE MICHIGAN, NORTH OF WAUKEGAN, ILLINOIS—IMPROVEMENT OF FOX AND WISCONSIN RIVERS.

REPORT OF MAJOR CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Manistique Harbor, Michigan.
2. Cedar River Harbor, Michigan.
3. Menomonee Harbor, Michigan and Wisconsin.
4. Oconto Harbor, Wisconsin.
5. Pensaukee Harbor, Wisconsin.
6. Green Bay Harbor, Wisconsin.
7. Harbor of Refuge at entrance of Sturgeon Bay Canal, Wisconsin.
8. Ahnapee Harbor, Wisconsin.
9. Kewaunee Harbor, Wisconsin.
10. Two Rivers Harbor, Wisconsin.
11. Manitowoc Harbor, Wisconsin.
12. Sheboygan Harbor, Wisconsin.
13. Port Washington Harbor, Wisconsin.
14. Harbor of Refuge at Milwaukee Bay, Wisconsin.
15. Milwaukee Harbor, Wisconsin.
16. Racine Harbor, Wisconsin.
17. Kenosha Harbor, Wisconsin.
18. Waukegan Harbor, Illinois.
19. Fox and Wisconsin rivers, Wisconsin.
20. Operating and care of locks and dams on the Fox River, Wisconsin.

EXAMINATIONS.

21. Centreville Creek, Manitowoc County, Wisconsin.
22. Kenosha Harbor, Wisconsin, for refuge.
23. Oconto Harbor, Wisconsin, channel 16 feet deep and 75 feet wide from piers to first contour in river at Spies Slough.
24. Racine Harbor, Wisconsin, enlarging and deepening channel.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 10, 1889.

SIR: I have the honor to transmit herewith annual reports for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1889.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

III.

IMPROVEMENT OF MANISTIQUE HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into the mouth of the Manistique River, where the harbor of Manistique is situated.

Project.—The original project, adopted in 1880, provided for the excavation of about 20,000 cubic yards of material to complete a channel 150 feet wide and 12 feet deep between the piers constructed by local enterprise at the mouth of the Manistique River.

Present works.—No construction work was done by the United States Government.

Depth of water.—Originally there was but a depth of 7 feet, which was increased to 10 feet before any appropriation had been made by the Government. The present depth is unknown.

Operations during the fiscal year.—None.

Remarks and recommendations.—An appropriation of $5,000 was made for this harbor in 1880, and one of $1,000 in 1881.

The only work done under these appropriations was the removal of 11,780 cubic yards of material in 1880, under a contract with the Chicago Lumbering Company.

In October, 1880, a survey of the harbor showed that the direction of the piers lay across the natural channel. At this time a storm had carried away about 330 feet of the west pier, and the company which had built the pier and had also secured the contract for dredging had determined to rebuild this portion of the pier. Maj. H. M. Robert, Corps of Engineers, United States Army, the officer then in charge, notified the superintendent of the company that the pier lines would have to be rectified so as to conform to the natural channel. The company declining to accede to this request, their contract, which had been extended from December, 1880, to June, 1881, was suspended. There have been no operations at this harbor since, and no money is asked for its improvement.

Estimated cost (see Report of Chief of Engineers, 1880, page 1931)	$6,000.00
Appropriated	6,000.00

Money statement.

July 1, 1888, amount available	$3,101.79
July 1, 1889, balance available	3,101.79

Commercial statistics for the calendar year ending December 31, 1888.

[Furnished by W. H. Hill.]

Name of harbor, Manistique, Mich.; collection district, Superior, Mich.; nearest light-house, Poverty Island, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	235	100,708.77	235	100,708.77
Sail	146	12,994.00	146	12,994.00
Total	381	113,702.77	381	113,702.77

Principal articles of export and import.

EXPORTS.

Lath	number..	12,586,307	Posts, fence	number..	5,219
Lumber	feet, B. M..	64,237,985	Shingles	do....	9,366,000

Total approximate value, $810,000.

IMPORTS.

Apples	barrels..	1,400	Iron and steel	pounds..	50,000
Brick	number..	100,000	Live stock	number..	500
Beer and liquors	barrels..	400	Merchandise, general	tons..	800
Coal	tons..	1,000	Oats	bushels..	22,000
Corn	bushels..	2,000	Oil	barrels..	550
Flour	barrels..	3,000	Salt	do....	300
Hay	tons..	800			

Total approximate value, $335,000.

II 2.

IMPROVEMENT OF CEDAR RIVER HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Green Bay into Cedar River, where the harbor of Cedar River is located.

Project.—The original project adopted in 1883 provided for the construction of two parallel piers 200 feet apart, extending from the mouth of Cedar River to the 16-foot contour in Green Bay, and dredging a channel between them 14 feet deep; also removing an outer shoal by dredging to a depth of 15 feet.

A modification of this project approved in 1884 provided for continuing the piers in a direct line with the part already built instead of at an angle, as originally proposed.

Present works.—Pile-piers lined with sheet-piling: (1) East pier, 754 feet in length, 16 feet wide; (2) west pier, 301 feet in length, 16 feet wide. All were built in 1883–1885 and are in good condition.

Depth of water.—Originally 8 to 10 feet, obstructed by a 3-foot bar in front of the mouth.

Soundings made in October, 1885, showed a channel about 50 feet in width, 13 feet deep, and 100 feet in width, 11 feet deep.

Operations during the fiscal year.—Not any.

Remarks and recommendations.—The commerce of Cedar River is entirely local and incidental to a single saw-mill. A harbor of refuge does not seem to be needed at this point, and if it were, the conditions are not favorable for its construction. No appropriation for continuing this improvement has been recommended since 1885.

Original estimate (see Report of Chief of Engineers, 1882, page 2121)	$138,000
Appropriated	30,000

Money statement.

July 1, 1888, amount available	$2,335.02
July 1, 1889, balance available	2,335.02

Amount (estimated) required for completion of existing project	108,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics for the calendar year 1888.

[Furnished by Spalding Lumber Company.]

Name of harbor, Cedar River, Michigan; collection district, Superior, Michigan; nearest light-house, Chambers' Island, Wisconsin.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam	200	50,000	200	50,000
Sail	185	62,000	185	62,000
Total	385	112,000	385	112,000

Principal articles of export and import.

EXPORTS.

Bark ..... cords..	200	Shingles ..... number..	10,000,000
Hides ..... pounds..	7,500	Piles ..... feet..	500,000
Lath ..... number..	5,000,000	Timber, squared ..... linear feet..	200,000
Lumber ..... feet, B. M..	28,000,000	Ties, railroad ..... number..	175,000
Poles, telegraph ..... number..	2,000	Wood ..... cords..	4,500
Posts, fence ..... do....	250,000		

Total approximate value, $800,000.

IMPORTS.

Apples ..... barrels..	300	Live stock ..... number..	200
Brick ..... number..	75,000	Lime ..... barrels..	200
Beer and liquors ..... barrels..	500	Merchandise, general ..... tons..	300
Coal ..... tons..	100	Oats ..... bushels..	12,000
Corn ..... bushels..	1,000	Oil ..... barrels..	200
Flour ..... barrels..	1,500	Provisions ..... pounds..	35,000
Hay ..... tons..	350	Salt ..... do....	75,000
Iron and steel ..... pounds..	25,000	Saw-logs ..... feet, B. M..	200,000

Total approximate value, $150,000.

II 3.

IMPROVEMENT OF MENOMONEE HARBOR, MICHIGAN AND WISCONSIN.

Object.—To secure a navigable channel from Green Bay into Menomonee River, where the harbor of Menomonee is situated.

Project.—The original project, adopted in 1871, provided for the construction of two parallel piers, 400 feet apart, extending from the mouth of the river to the 15-foot contour in Green Bay, and dredging a channel between them 14 feet deep. In 1874 it was decided to extend the piers to the 16-foot contour.

Present works.—(1) North pier, 1,854 feet in length, consisting of 585 feet of slab-pier 20 feet wide; 609 feet of pile-pier, 481 feet of the same having a width of 14 feet, and 128 feet a width of 18 feet; 660 feet of cribs, 610 feet with a width of 20 feet, and 50 feet with a width of 24 feet. (2) South pier, 2,710 feet in length, consisting of 1,900 feet of pile-pier, 1,804 feet having a width of 14 feet, and 96 feet a width of 18 feet; and 810 feet of cribs 20 feet wide.

The pile-piers were built 1871–1874, and the cribs 1876–1884.

The cribs are in good condition. It is probable that some repairs will be needed to the pile-piers at an early date.

Depth of water.—Originally 4 feet. In 1880, at the outer end of the north pier, 16 feet; south pier, 11 feet. In 1886 a channel 270 feet in width and 14 feet deep was dredged between the piers and through an outer bar that projected from the south pier head.

Operations during the fiscal year.—A survey ordered by act of Congress approved August 11, 1888, with a view of deepening the channel to 16 feet, and extending it up the river for a distance of about 2 miles, is nearly completed.

A special report relating to this subject will be transmitted as soon as the necessary maps and estimates can be prepared. There have been no other operations during the fiscal year.

Remarks and recommendations.—The navigation of this harbor presents some peculiar and exceptional features, viz: Vessels entering for cargoes come light, and no heavily-laden craft seek it for shelter; the departing lumber-laden vessels, with a draught of 13 or 14 feet, wait for smooth water, and consequently the usual allowance of 4 feet play in depth is not necessary at this harbor.

The extension of the south pier, under the present project, is not considered necessary, for if the bar should reform, it could be removed by dredging at small expanse.

The Menomonee Lumber Company still continue their unauthorized and improper use of the south pier by piling their lumber thereon, while they moor heavy barges and scows to the north pier.

It is proposed to apply available funds to the maintenance of the channel and piers.

Original estimate (see Report of Chief of Engineers, 1874, Part 1, page 139)	$212,000
Appropriated	212,000

Money statement.

July 1, 1888, amount available	$2,370.30
Fuel sold to officers, deposited to credit of appropriation	20.00
Amount appropriated by act of August 11, 1888	9,000.00
	11,390.30
July 1, 1889, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1888	316.46
July 1, 1889, balance available	11,073.84

Commercial statistics for the calendar year 1888.

[Furnished by C. H. Call, collector of customs.]

Name of harbor, Menomonee, Michigan and Wisconsin; collection district, Superior, Michigan; nearest light-house, Menomonee, Michigan.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	280	240,600	280	240,600
Sail	415	261,790	415	261,790
Total	695	502,390	695	502,390

Principal articles of export and import.

EXPORTS.

Lath	number..	60,000,000	Shingles	number..	65,000,000
Lumber	feet, B. M..	250,000,000	Ties, railroad	do....	85,000
Pickets, fence	number..	1,000,000	Wood	cords..	2,000

Total approximate value, $7,593,500.

IMPORTS.

Merchandise, general		$1,710,000	Saw-logs	feet, B. M..	250,000,000

Total approximate value, $3,210,000.

II 4.

IMPROVEMENT OF OCONTO HARBOR, WISCONSIN.

Object.—To secure a navigabla channel from Green Bay up the Oconto River to the city of Oconto.

Project.—The original project adopted in 1882 provided for the formation of a channel 100 feet wide and 8 feet deep, by extending the slab-pier built by the city to the 10-foot contour in Green Bay, and dredging between the piers and up the river to Section Street Bridge, a distance of about 2 miles; the piers to be parallel to each other and 150 feet apart.

Present works.—(1) North pier, 1,603 feet long, 20 feet wide. For 1,000 feet the piles are 5 feet apart; for the remaining 503 feet the piles are 4 feet apart on the channel side and 2 feet apart on the outer side, the latter being provided with walling timbers, cross-ties and tie-rods. The filling is composed of slabs and edgings ballasted with sand. (2) South pier, 2,151 feet long, 20 feet wide. For 1,850 feet the piles are 5 feet apart; the remaining 351 feet is close piling. The filling is composed of slabs and edgings ballasted with sand, except the outer 301 feet, which is covered with 2 feet thickness of stone. (3) The outer side of the south pier, beginning 300 feet from the outer end, for a distance of 1,000 feet, is protected from ice pressure by a line of close piling, thence shoreward for a distance of 850 feet by riprap. (4) Additional stability is given to 1,850 feet of the south pier by a line of piles on the channel side 3 feet apart, provided with walling timbers, cross-ties, and iron tie-rods at intervals of 9 feet.

These piers were built 1882-1885, and are in fair condition, except that sections 1 and 2 of the north pier for a length of about 75 feet were reported damaged May 12, 1889, by fire.

Depth of water.—Originally 2 feet, increased to 3½ feet by local enterprise. Soundings made in November, 1888, showed a channel between the piers of about 5 feet in depth, a shoaling of nearly 3 feet since July, 1887. To restore this portion of the improvement to the depth contemplated by the present project will require the removal of 34,000 cubic yards of material. The channel in the river was also probably seriously damaged by the severe freshet that caused the shoaling between the piers.

Operations during the fiscal year.—By hired labor and open purchase 650 feet of re-enforcement piling were built on the channel side of the south pier, and 600 feet provided with riprap on the opposite side of the pier.

Minor repairs were also made to sections 8 to 13 of the north pier.

Remarks and recommendations.—It is contemplated to repair the damages caused by fire to the north pier, and to do dredging with one and probably two United States dredges this season as soon as they can be spared from work that is more urgent. It is probable that the funds available will admit of continuing the dredging in the spring of 1890.

The history of this work of improvement is somewhat peculiar.

A survey of the mouth of the Oconto River was ordered by the act of July 11, 1870, and was made in the same year under the direction of Maj D. C. Houston, Corps of Engineers, who reported that—

> General commerce and navigation will not be benefited by a harbor at this point. The amount required for the entire and permanent completion of the work is $500,000.00. (See Report of Chief of Engineers for 1871, page 121.)

The act of March 3, 1879, directed a re-examination or survey, which was also made under Major Houston's direction, and in October, 1879, that officer reported a reduced estimate, amounting to $382,027.18. (See Report of Chief of Engineers for 1880, page 1974). Both of these estimates were based on securing a 12-foot channel.

In January, 1881, the Secretary of War was informed that the citizens of Oconto had undertaken the work of improvement on a much more economical plan than that recommended by the Government engineer, and a request was made for a further examination, with the hope that a small appropriation might be made in *aid* of the work. Major Houston made an examination, and, while not indorsing the method of construction adopted by the citizens, reported that an appropriation of $5,000 or $10,000 "would be of great assistance" to the people in carrying on the work of improvement.

The character of the citizens' plan and estimate may be judged from the fact that they proposed to build 1,800 feet of pier for $1,500, or 83⅓ cents per linear foot.

The act of March 3, 1881, appropriated $10,000 for improving Oconto Harbor, it is believed, on the strength of the above-quoted remark of Major Houston.

Maj. H. M. Robert, Corps of Engineers, having succeeded to the charge of the work, submitted a project in 1881 to obtain an 8-foot channel, at an estimated cost of $125,000. This was modified in 1883, the revised estimate involving a total cost of $150,000, which is the project at present being carried out.

The first appropriation for the harbor was made in 1881, and work was begun in the ensuing year.

The channel is often used for booming and mooring logs and lumber scows, and the piers, built in the cheapest practicable manner, are constantly receiving injuries from such use, the piles being frequently broken and the slab-filling washing out. That part of the piers built by the citizens was repaired by the local authorities in July and August, 1888.

The south pier is built to the full length contemplated by the approved project.

To complete the north pier to the 10-foot contour, as originally designed, would require an extension of 875 feet, at a cost of about $10,000. As the south pier is the weather pier, and as the north pier is protected by the south pier and by Peshtigo Point, on the north, it would seem to be unnecessary to extend the north pier any farther.

It is recommended that, if Congress should continue to make appropriations for this improvement, the expenditure of the money be made contingent on the city of Oconto keeping in repair the part built by private enterprise.

List of material and labor used in building 650 linear feet of re-inforcement piling and riprapping 600 feet of the south pier, and making minor repairs to the north pier at Oconto Harbor, Wisconsin, in 1888.

Articles.	Quantity.	Price.	Amount.
Round piles.....linear feet..	5,400	$0.10	$540.00
Pine timber.....feet, B. M..	14,976	15.00	224.64
Iron screw-bolts and tie-rods.....pounds..	10,750	2.65	284.87
Stone.....cords..	99.9	2.50	249.65
Driving piles.....each..	216	2.0972	453.00
Rent of scow and towing.....	.....	.....	98.50
Sundry supplies and tools.....	.....	.....	10.28
Labor.....	.....	.....	386.94
Total.....	.....	.....	2,341.89

Estimated cost (see Report of Chief of Engineers for 1883, page 1646)..... $150,000
Appropriated..... 68,000

Money statement.

July 1, 1888, amount available.....	$199.64
Amount appropriated by act of August 11, 1888.....	20,000.00
	20,199.64
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888.....	4,213.31
July 1, 1889, balance available.....	15,986.33
Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	82,000.00

Commercial statistics for the calendar year 1888.

[Furnished by W. H. Young.]

Name of harbor, Oconto, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Sherwood Point, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam.....	127	7,320	140	7,560
Sail.....	90	28,900	103	33,000
Total.....	217	36,220	243	40,560

Principal articles of export and import.

EXPORTS.

Apples	barrels..	1,200	Merchandise, general	tons..	450
Bark	cords..	2,350	Mill-stuffs	do....	300
Barley	bushels..	2,000	Peas	bushels..	2,000
Beans	do....	1,600	Plaster, land	tons..	60
Beer	barrels..	5,000	Pork	barrels..	2,400
Eggs	dozen..	400	Provisions	pounds..	400,000
Fish	pounds..	3,000,000	Potatoes	bushels..	4,000
Hay	tons..	360	Poles, telegraph	number..	20,000
Hides	pounds..	45,000	Posts, fence	do....	677,000
Lath	number..	19,200,000	Shingles	do....	48,000,000
Lumber	feet, B. M..	53,000,000	Ties, railroad	do....	350,000
Live stock	number..	300			

Total approximate value, $1,335,000

Principal articles of export and import—Continued.

IMPORTS.

Apples	barrels..	1,000	Lath	number..	300,000
Barley	bushels..	6,000	Lime	barrels..	4,000
Brick	number..	450,000	Merchandise, general	tons..	16,000
Beer and liquors	barrels..	4,000	Oats	bushels..	150,000
Coal	tons..	1,600	Oil	barrels..	700
Corn	bushels..	20,000	Provisions	pounds..	460,000
Flour	barrels..	12,000	Salt	barrels..	350,000
Hay	tons..	1,800	Shingles	number..	600,000
Iron and steel	pounds..	240,000	Saw-logs	feet, B. M..	27,000,000
Live stock	number..	900	Wheat	bushels..	8,000
Leather	pounds..	140,000	Wool	pounds..	2,500
Lumber	feet, B. M..	500,000	Wood	cords..	300

Total approximate value, $471,000.

II 5.

IMPROVEMENT OF PENSAUKEE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Green Bay into the Pensaukee River.

Project.—The original project, adopted in 1883, provides for continuing a slab-pier, which had been built by private enterprise, until it should reach the 10-foot contour in Green Bay, and dredging a channel south of it to a depth of 10 feet and width of 100 feet, connecting the deep water in the river with the deep water in the bay.

Present works.—(1) A slab-pier 1,300 feet long and 20 feet wide, filled with slabs and edgings and ballasted with sand. It was built in 1883, repaired in 1885, and is in fair condition. (2) One thousand six hundred feet of slab-pier, built by private enterprise, was nearly all destroyed by a storm in 1885. The destruction of this work left the portion of the pier built by the United States a detached work.

Depth of water.—Originally 2 feet, increased by private enterprise to from 7 to 9 feet for a width of 30 feet. The destruction of the portion of the pier built by private enterprise by the storm of October, 1885, resulted in restoring the channel to about its original condition.

Operations during the fiscal year.—Not any.

Remarks and recommendations.—There is no commerce at this harbor, and consequently no necessity for asking for an appropriation for continuing the improvement.

Estimated cost (see Report of Chief of Engineers, 1883, page 1652)	$50,000
Appropriated	15,000

Money statement.

July 1, 1888, amount available	$4,059.92
July 1, 1889, balance available	4,059.92
Amount (estimated) required for completion of existing project	35,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

II 6.

IMPROVEMENT OF GREEN BAY HARBOR, WISCONSIN.

Object.—To secure a more direct and deeper channel from Green Bay into the mouth of the Fox River, where the harbor of Green Bay is located.

Project.—The original project, adopted in 1866, provided for dredging a channel 200 feet wide and 12 feet deep from the mouth of the Fox

River, through Grassy Island, to the 12-foot contour in Green Bay, a distance of about 8,800 feet, and revetting some 650 feet of the same at Grassy Island. This project was completed in 1871.

A supplementary project, adopted in 1872, provided for straightening the channel and increasing its depth to 13 feet.

In 1874 it was decided to increase the depth to 14 feet; this increased the length to about 10,600 feet.

Present works.—Revetments at Grassy Island. (1) West revetment 620 feet long and 14 feet wide, with close piling on the channel side and anchor piles about 5 feet apart on the outer side. The timber superstructure is 5 feet high. This revetment was built in 1870, rebuilt above water-line in 1887, and is in good condition. (2) East revetment 705 feet long and 14 to 17 feet wide, with close piling on the channel side, and on the bay side close piling for 425 feet, and for the remaining 280 feet piles about 5 feet apart. The timber superstructure is 7 feet high. This revetment was built in 1869, rebuilt above the water-line in 1885, and is in good condition.

Depth of water.—Originally a narrow and circuitous channel 6 feet in depth. The last dredging was done in 1885. At that date the channel was reported to be 200 wide and 14 feet deep, except for a distance of 1,000 feet between Grassy Island and the angle, where its width was but 175 feet, the remaining 25 feet on the east side having a depth from 10 to 12 feet.

Operations during the fiscal year.—Not any.

Remarks and recommendations.—It is proposed to expend the funds appropriated by act of Congress approved August 11, 1888, or as much of the same as may be necessary, in dredging the channel to the dimensions required by the existing project, as soon as the dredges can be spared from more urgent work.

Small annual expenditures will be necessary to maintain this long, narrow channel.

For the maintenance of the channel, and revetments at Grassy Island, an appropriation of $10,000 is recommended for the fiscal year ending June 30, 1891.

Estimated cost of present project (see Report of Chief of Engineers, 1881, page 2069)	$135,000
Appropriated	115,000

Money statement.

July 1, 1888, amount available	$208.03
Amount appropriated by act of August 11, 1888	10,000.00
	10,208.03
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	150.50
July 1, 1889, balance available	10,057.53
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1666 and 1867.	

Commercial statistics for the calendar year 1888.

[Furnished by Robert Barclay, deputy collector of customs.]

Name of harbor, Green Bay, Wisconsin; collection district, Milwaukee, Wis.; nearest light-house, Grassy Island, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	394	72, 863	408	73, 552
Sail	161	35, 665	163	35, 975
Total	555	108, 528	571	109, 527

Principal articles of export and import.

EXPORTS.

Brick	number..	1, 822, 325	Lumber	feet, B. M..	8, 669, 200
Cattle	do....	588	Malt	bags..	1, 514
Flour	barrels..	193, 317	Merchandise, general	tons..	1, 814
Flour	sacks..	4, 817	Merchandise, general	packages..	25, 817
Grain	bushels..	158, 795	Mill-stuffs	tons..	1, 343
Hay	tons..	120	Potatoes, etc	bushels..	1, 692
Horses	number..	65	Salt	barrels..	1, 807
Iron, pig	tons..	2, 000	Stone	cords..	133
Lime	barrels..	1, 183			

IMPORTS.

Brick	number..	16, 000	Merchandise, general	tons..	3, 457
Coal	tons..	84, 200	Merchandise, general	packages..	20, 945
Crockery	do....	14	Oil	barrels..	5, 613
Hay	do....	66	Salt	do....	26, 245
Horses	number..	16	Shingles	number..	1, 239, 500
Lath	do....	65, 000	Wood, etc	cords..	4, 632
Lumber	feet, B. M..	1, 755, 000			

II 7.

HARBOR OF REFUGE AT ENTRANCE OF STURGEON BAY CANAL, WISCONSIN.

Object.—To form a harbor of refuge inclosing the Lake Michigan entrance to the Sturgeon Bay and Lake Michigan Ship Canal, and also afford a safe entrance to the canal in rough weather.

Project.—The original project was submitted in 1871 and adopted in 1873. It provided for the construction of converging piers inclosing a triangular area of about 10 acres which was to be dredged out to the requirements of navigation at that time. The piers were about 1,200 feet long, 850 feet apart at the shore line, and 250 feet at the outer end.

Supplementary projects adopted in 1879 and 1880 did not change the original project, but provided for sheet-piling the pile-piers, extending each pier 150 feet by detached works, so as to increase the width of entrance from 235 feet to 335 feet, and dredging to obtain at least 16 feet in depth over so much of the area of the basin as would be useful to vessels entering the harbor.

Present works.	Width.	North pier, length.	South pier, length.
	Feet.	*Feet.*	*Feet.*
Slab-pier:			
Piles 4 feet apart	14	100	100
Close piling	14	150	150
Pile-pier, close piling	14	512	512
Do	18	32	32
Crib-pier	20	200	200
Do	24	200	200
Length of each main pier		1,194	1,194
Crib-piers	24	100	100
Do	30	50	50
Length of each detached pier		150	150
Total length of each pier		1,344	1,344

Guide-piling to connect main and detached piers, total	feet	238
North slab and pile-pier, sheet-piled	do	682
South slab and pile-pier, sheet-piled	do	700
Number of cubic yards of material dredged		132,344

The slab and pile piers were built in 1873–'74; the pile-piers are in fair condition; the slab-piers are much decayed above the water-line and need rebuilding.

The crib-piers and guide-piling were built 1878–1884, and are in good condition.

Depth of water.—Soundings made in June, 1887, show the least depth of water at the entrance to be 15.7 feet; thence to the canal there is an available channel 14 feet in depth.

Operations during the fiscal year.—Not any.

Remarks and recommendations.—It is contemplated to expend the available funds during the present working season in repairs to the piers, and dredging if necessary.

As stated in previous reports, the advantages expected to accrue to vessels navigating Lake Michigan, when the construction of a harbor of refuge at this place was projected, have not been entirely realized.

In tempestuous weather the harbor is too limited and does not afford sufficient security to vessels seeking its shelter, often necessitating their passage through the canal to avail themselves of the superior advantages afforded by the natural harbor of Sturgeon Bay.

I am officially informed by the president of the canal company that the practice of exacting tolls from vessels using the canal as a harbor of refuge was discontinued three years ago.

For the maintenance of the channel and piers for the fiscal year ending June 30, 1891, an appropriation of $3,000 is recommended.

Estimated cost (see Report of Chief of Engineers, 1874, Part I, page 141)	$180,000
Appropriated	165,000

Money statement.

July 1, 1888, amount available	$3,640.42
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	74.00
July 1, 1889, balance available	3,566.42
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts 1866 and 1867.	3,000.00

Commercial statistics for the calendar year 1888.

[Furnished by Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company.]

Name of harbor, Harbor of Refuge at entrance of Sturgeon Bay Canal; collection district, Milwaukee, Wis.; nearest light-house, entrance to harbor.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	1,424	146,253	1,425	146,253
Sail	904	220,828	905	220,829
Total	2,328	367,081	2,330	367,082

Principal articles of export and import.

EXPORTS.

Bark	cords..	500	Potatoes	bushels..	5,000
Butter	pounds..	20,000	Poles, telegraph	number..	2,000
Cheese	do....	6,000	Posts, fence	do....	40,000
Eggs	dozen..	5,000	Stone	cords..	10,000
Fish	pounds..	200,000	Ties, railroad	number..	40,000
Lumber	feet, B. M..	149,000,000	Wood	cords..	7,000
Peas	bushels..	2,000			

IMPORTS.

Apples	barrels..	2,000	Leather	pounds..	50,000
Brick	number..	150,000	Merchandise, general	tons..	10,400
Beer and liquors	barrels..	500	Oats	bushels..	20,000
Coal	tons..	2,000	Oil	barrels..	5,000
Corn	bushels..	10,000	Plaster, rock	tons..	500
Flour	barrels..	5,000	Provisions	pounds..	1,000,000
Hay	tons..	2,000	Salt	barrels..	30,000
Iron and steel	pounds..	400,000	Saw-logs	feet, B. M..	1,000,000
Live stock	number..	2,000	Wheat	bushels..	5,000

II 8.

IMPROVEMENT OF AHNAPEE HARBOR, WISCONSIN.

Object.—To secure a small artificial harbor for local purposes in Wolf River, with a navigable channel leading thereto from Lake Michigan.

Project.—The project of improvement adopted in 1875 provided for the formation of a small artificial harbor connected with the lake by a channel 100 feet wide and 12 feet deep, to be formed by the construction of two piers extending from the shore-line to the 18-foot contour in the lake; also for blasting and dredging rock from the river-bed near the mouth of the river up for a distance of 750 feet.

In accordance with the modification of the original project approved September 27, 1884, the cribs sunk in extension of the piers have been placed 50 feet further from the center line of the channel than the old piers, and will afford, when completed, a 200 foot entrance between the pier heads.

Present work.—(1) North pier, 1,052 feet in length, composed of 352 feet of pile-pier, 320 of which is 14 feet wide, and 32 feet 20 feet wide; also, 700 feet of cribs 20 feet wide. (2) South pier, 1,125 feet in length, composed of 625 feet of pile-pier 14 feet wide, and 500 feet of cribs 20 feet wide.

The pile-piers were built 1871–1874, and are in fair condition. The crib-piers were built 1875–1889, and are in good condition.

Depth of water.—Originally 2 feet. Soundings made in May, 1889, show a depth of water at the entrance of 14 feet, and a narrow but available channel between the piers with a least depth of 10 feet.

Operations during the fiscal year.—As soon as possible after the funds appropriated by act approved August 5, 1886, and August 11, 1888, became available, preparations were made for pier extension, dredging, and drilling and blasting rock in the channel, by hired labor and purchasing of material in open market.

Work was begun September 24, 1888, and closed for the season November 24.

May 1, 1889, work was resumed, the dredging plant having been repaired during the winter.

The results of the operation during the fiscal year are the removal of 3,496 cubic yards of rock and 19,965 cubic yards of sand, etc., from the channel; resetting Crib No. 8 of the south pier; building 250 linear feet of superstructure 6 feet in height upon Cribs Nos. 8, 9, and 10 of the south pier and 10 and 11 of the north pier; and the commencement of 200 feet extension to the north pier. Of the latter, 150 linear feet are completed below the water-line, and the remainder is well under way.

Remarks and recommendations.—Work is now in progress at this harbor, and it is contemplated to expend the funds available during the present working season.

The results expected to be obtained from this expenditure are the entire completion of the rock excavation, and nearly or quite all of the dredging of sand, etc. Also completing all of the pier construction, except one crib for each pier-head, and 200 feet of superstructure upon the cribs sunk this season in extension of the north pier.

The present project can probably be completed with the balance of the estimate not yet appropriated, viz, $15,000, and when finished it will meet the present and prospective demands of commerce.

Should an appropriation be made for the fiscal year ending June 30, 1891, it is proposed to expend it in the construction of pier-heads to the north and south piers, and of superstructure upon 200 linear feet of the north pier, and for the maintenance of the channel and piers. An appropriation of $15,000 is recommended.

Estimated cost (see Report of Chief of Engineers for 1876, Part II, pages 346–359)	$175,000.00
Appropriated	160,000.00

Money statement.

July 1, 1888, amount available		$15,274.62
Amount appropriated by act of August 11, 1888		5,000.00
		20,274.62
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$14,529.06	
July 1 1889, outstanding liabilities	478.83	
		15,007.89
July 1, 1889, balance available		5,266.73

Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics for the calendar year 1888.

[Furnished by M. T. Parker.]

Name of harbor, Ahnapee, Wis.; collection district, Milwaukee, Wis.; nearest lighthouse, Stur eon Bay, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	260	74,430	259	74,149
Sail	299	59,501	296	56,914
Total	559	133,931	555	131,063

Principal articles of export and import.

EXPORTS.

Bark	cords	275	Merchandise, general	tons	60
Barley	bushels	10,000	Mill-stuffs	do	50
Brick	number	100,000	Oats	bushels	20,000
Butter	pounds	40,000	Peas	do	100,000
Cheese	do	975,000	Pork	barrels	200
Eggs	dozen	35,000	Provisions	tons	80
Fish	pounds	240,000	Potatoes	bushels	25,000
Furniture	pieces	1,000	Posts, fence	number	100,000
Hay	tons	1,500	Shingles	do	1,000,000
Hides	pounds	70,000	Ties, railroad	do	50,000
Flour	barrels	3,000	Wheat	bushels	100,000
Leather	pounds	20,000	Wood	cords	2,500
Lumber	feet, B. M.	300,000	Wool	pounds	8,000
Live stock	number	325			

Total approximate value, $440,000.

IMPORTS.

Apples	barrels	400	Lumber	feet, B. M.	250,000
Beer and liquors	do	1,200	Laths	number	100,000
Coal	tons	200	Merchandise, general	tons	1,000
Corn	bushels	800	Oil	barrels	800
Hay	tons	200	Plaster, rock	tons	140
Iron and steel	pounds	80,000	Provisions	pounds	980,000
Live-stock	number	200	Salt	barrels	1,500
Leather	pounds	41,000	Shingles	number	400,000

Total approximate value, $298,000.

II 9.

IMPROVEMENT OF KEWAUNEE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the Kewaunee River where the harbor of Kewaunee is situated.

Project.—The project for the improvement of this harbor was adopted in 1881, and provides for the formation of a channel from a point about 2,000 feet south of the original mouth of the Kewaunee River through a spit of land about 300 feet wide, affording communication between the river and Lake Michigan. From the lake end of this cut two parallel piers 200 feet apart are to be constructed, each 1,650 feet long and extending to the 18-foot contour. Between the piers and through the cut the channel is to be dredged to a depth of 14 feet.

Present works.—Pile-piers lined with sheet-piling: (1) The north pier is 1,000 feet long and 16 feet wide. (2) The south pier is 775 feet long and 16 feet wide. They were built 1881–1887 and are in good condition.

Depth of water.—Originally 2 feet.

Upon the opening of navigation in the spring of 1889 there was a depth of 9 feet. By dredging in April this was increased to 12 feet, which is as great a depth as can be maintained until the piers are extended. The old river-bed north of the new entrance has also been dredged, forming a basin 475 feet long, 150 feet wide, and 10 feet deep.

Operations during the fiscal year.—By hired labor and the use of United States Dredge No. 1, 7,280 cubic yards of material were removed from the channel between the piers.

The dredge was employed at this harbor from the 3d to the 27th of April, 1889, and in addition to the foregoing quantity of dredging reported, on stormy days, when it was impracticable to dredge between the piers, the inner harbor was improved by the removal of 5,231 cubic yards of material for the city of Kewaunee and private parties, without expense to the United States.

Under contract dated October 31, 1888, with Messrs. Knapp and Gillen, of Racine, Wis., for extending the south pile-pier 300 feet, work began April 30, 1889. At the close of the fiscal year 100 linear feet were nearly completed.

The remainder is well under way, and will probably be completed in July.

Remarks and recommendations.—The conditions at this place are unusually favorable for the construction and maintenance of an excellent harbor.

Up to date $55,000 have been appropriated by the United States and $8,000 by the local authorities, an aggregate of $63,000.

The result obtained from this expenditure will be the formation of a channel of navigable width, 12 feet in depth, by the construction of 2,075 linear feet of pile-pier and the dredging of 133,291 cubic yards of material.

The value of the harbor in its present incomplete condition is shown by the fact that during a severe northeast storm that occurred in November, 1888, seventeen vessels sought and obtained shelter there.

Should an appropriation be made for the fiscal year ending June 30, 1891, it is contemplated to expend it chiefly in pier construction and dredging. Repairs to the present piers may require a small outlay. An appropriation of $50,000 is recommended.

Estimated cost (see Report of Chief of Engineers for 1881, page 2084)..	$200,000.00
Appropriated by the United States	55,000.00
Appropriated by the local authorities	8,042.72
Total	63,042.72

Money statement.

July 1, 1888, amount available		$189.37
Amount appropriated by act of August 11, 1888		10,000.00
		10,189.37
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$1,521.36	
July 1, 1889, amount covered by existing contracts	8,000.00	
		9,521.36
July 1, 1889, balance available		668.01

Amount (estimated) required for completion of existing project	$137,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for building 300 linear feet pile-pier, Kewaunee Harbor, Wisconsin, received in response to advertisement dated September 20, 1888.

[Opened October 22, 1888, by Maj. Charles E. L. B. Davis, Corps of Engineers.]

	1. F. M. Knapp and E. Gillen, Racine, Wis.	2. Horatio Truman and George Cooper, Manitowoc, Wis.	3. Christopher H. Starke, Milwaukee, Wis.
Round piles, 12,000 linear feet ..... per linear foot..	$0.19	$0.22	$0.25
Norway sheet-piling, 48,000 feet, B. M ..... per 1,000..	29.00	30.00	32.00
White-oak timber, 18,400 feet, B. M ..... do....	49.00	48.00	50.00
White-pine timber, 12 by 12 inches, 520 linear feet. per linear foot..	.25½	.28	.40
White-pine timber, 6 by 12 inches, 620 linear feet ..... do ..	.16	.20	.40
White-pine plank, 3,000 feet, B. M ..... per 1,000..	15.50	18.00	25.00
Stone, 450 cords ..... per cord..	5.50	6.00	7.00
Wrought-iron screw-bolts and tie-rods, 8,000 pounds. per pound..	.05½	.06	.06
Wrought-iron spikes, 900 pounds ..... do....	.04½	.04	.06
Total	7,968.10	8,663.60	9,855.20

With approval of the Chief of Engineers a contract was entered into October 31, 1888, with Knapp & Gillen, the lowest responsible bidders for this work.

Commercial statistics for the calendar year 1888.

[Furnished by J. E. Lathrop, inspector.]

Name of harbor, Kewaunee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Twin River Point, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	316	96,696	316	96,696
Sail	214	18,647	214	18,647
Total	530	115,343	530	115,343

Compared with the previous year the increase in number of vessels is 28 per cent., and in the tonnage 44.7 per cent.

Principal articles of export and import.

EXPORTS.

Bark	cords..	2,800	Oats	bushels..	10,000
Barley	bushels..	12,000	Peas	do....	26,000
Brick	number..	50,000	Provisions	tons..	20
Butter	tons..	40	Potatoes	bushels..	8,000
Cheese	do....	75	Poles, telegraph	number..	300
Fish	do....	2½	Posts, fence	do....	75,000
Hay	do....	12,000	Shingles	do....	1,700,000
Hides	do....	5	Ties, railroad	do	150,000
Lumber	feet, B. M..	1,000,000	Wheat	bushels..	100,000
Live stock	number..	200	Wood	cords..	800
Mill-stuffs	tons..	200	Wool	tons..	1½

Total approximate value, $360,000, an increase over the previous year of 16 per cent.

Principal articles of export and import—Continued.

IMPORTS.

Apples	barrels..	1,500	Laths	number..	100,000
Beer and liquors	do....	200	Merchandise, general	tons..	2,000
Coal	tons..	150	Oil	barrels..	200
Corn	bushels..	6,000	Plaster, rock	tons..	500
Iron and steel	tons..	100	Provisions	do....	75
Leather	do....	3	Salt	barrels..	1,800

Total approximate value, $300,000, an increase over the previous year of 8 per cent

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I I 10.

IMPROVEMENT OF TWO RIVERS HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into Twin Rivers, where the harbor of Two Rivers is situated.

Project.—The project for the improvement of this harbor, adopted in 1870, provided for the construction of two parallel piers, extending from the river mouth to the 18-foot contour in Lake Michigan, and dredging between them to a depth of 12 feet.

Present works.—Pile and crib-piers: (1) North Pier, 1,810 feet long, composed of 1,060 feet of pile-pier, 14 feet wide, and 750 feet of cribs, 20 feet wide. (2) South Pier, 1,710 feet long, composed of 960 feet of pile-pier, 14 feet wide, and 750 feet of cribs, 20 feet wide. The pile-piers were built 1871–1874, and the cribs, 1875–1884. The latter are in good condition, but some filling and repairs will be required to the piling at an early date.

Depth of water.—Originally from 2 to 3 feet.

The channel was dredged to the required depth of 12 feet in 1885, since which time gradual shoaling has taken place. In April, 1889, soundings were made and a depth of but 9 feet was found in the shoalest place. The restoration of the channel to a depth of 12 feet, by dredging, was completed June 6, 1889.

Observations during the fiscal year.—By hired labor and the use of a United States dredge 12,772 cubic yards of material were removed from the channel. The dredging began May 1st and was completed June 6, 1889.

Remarks and recommendations.—It is not deemed necessary to urge an immediate completion of the original project, which would require an extension of the North Pier of about 400 feet, and the South Pier about 500 feet.

The commerce of this harbor is merely nominal, nearly all the freighting being done by rail.

The improvement has, however, furnished an inside landing-place for what commerce there is, a great advantage over piers extending from the shore into the open lake.

Should an appropriation be made for the fiscal year ending June 30, 1891, it is contemplated to expend it in making repairs to the pile-piers and dredging if necessary.

For future maintenance to the channel and making repairs to the pile-piers, an appropriation of $3,000 is recommended for the fiscal year ending June 30, 1891.

Estimated cost (see Report of Chief of Engineers, 1871, page 123)..... $265,588.80
Appropriated 200,500.00

Money statement.

July 1, 1888, amount available	$135.33
Amount appropriated by act of August 11, 1888	2,500.00
	2,635.33
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	1,395.96
July 1, 1889, balance available	1,239.37
Amount (estimated) required for completion of existing project	65,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1888.

[Furnished by Henry Mann.]

Name of harbor, Two Rivers, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pier-head, Two Rivers, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	257	210,000	270	198,250
Sail	150	11,350	149	11,290
Total	425	221,350	419	209,540

Principal articles of export and import.

EXPORTS.

Apples	barrels	400	Merchandise, general	tons	500
Beer	do	5,000	Mill-stuffs	do	300
Brick	number	1,000,000	Pease	bushels	2,000
Chairs	do	500,000	Plaster, land	tons	6,000
Cheese	pounds	10,000	Pork	barrels	100
Fish	do	1,000,000	Provisions	pounds	10,000
Furniture	pieces	50,000	Potatoes	bushels	1,500
Laths	number	200,000	Posts, fence	number	5,000
Leather	pounds	60,000	Shingles	do	2,000,000
Lumber	feet, B. M.	1,500,000	Wooden-ware	pieces	22,000,000
Live stock	number	400			

Total approximate value, $1,234,340.

IMPORTS.

Apples	barrels	1,500	Lumber	feet, B. M.	3,000,000
Bark	cords	3,000	Laths	number	1,000,000
Barley	bushels	5,000	Merchandise, general	tons	1,000
Brick	number	200,000	Oats	bushels	25,000
Beer and liquors	barrels	4,000	Oil	barrels	1,000
Coal	tons	20,000	Plaster, rock	tons	5,000
Corn	bushels	25,000	Provisions	pounds	10,000
Flour	barrels	4,000	Salt	barrels	10,000
Hides	pounds	5,000	Shingles	number	5,000,000
Hay	tons	500	Saw'logs	Feet, B. M.	15,000,000
Iron and steel	pounds	200,000	Wheat	bushels	500,000
Live stock	number	500	Wood	cords	5,000

Total approximate value, $946,500.

I I 11.

IMPROVEMENT OF MANITOWOC HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the Manitowoc River, where the harbor of Manitowoc is situated.

Project.—The original project, adopted in 1852, provided for the construction of two parallel crib-piers 220 feet apart, extending from the mouth of the Manitowoc River to the 12-foot contour in Lake Michigan. It was completed in 1871. In 1881, to meet the increased demands of commerce, a project was adopted for extending the piers to the 18½-foot contour and obtaining a channel of not less than 14 feet depth at the shore-line, increasing to 18 feet at the entrance. Pier extension under this project was completed in 1887 and the dredging in 1889.

Present works.—Crib-piers: (1) North pier, 1,970 feet long, composed of 1,220 feet of cribs 20 feet wide, and 750 feet 24 feet wide. (2) South pier, 1,900 feet long, composed of 1,150 feet of cribs 20 feet wide, and 750 feet 24 feet wide.

Depth of water.—Originally 3 feet.

Soundings made May 27, 1889, show the least depth at the entrance to be 16.4 feet, and a channel midway between the piers, about 100 feet wide, with a depth of 14 feet or over.

Operations during the fiscal year.—Upon the opening of navigation in 1888, it was found that the depth of water between the piers would not allow vessels drawing more than 12½ feet to enter the river.

The funds available were not sufficient to fit out a dredge and do the dredging required. The city of Manitowoc proposed to dredge a narrow channel through the bar with the understanding that the United States should at its convenience do an equal amount of dredging in the river for the city. Under this arrangement 2,230 cubic yards were removed, under my supervision, early in July, 1888.

As soon as possible after the funds appropriated by act approved August 11, 1888, became available, the United States dredge No. 2 was fitted out and dredging began September 21, and was continued until the close of navigation, November 24.

The work was resumed April 2, 1889, and completed May 4.

Twenty-eight thousand one hundred and twenty cubic yards of material were removed from the channel by the Government dredge. On stormy days, when it was impracticable to dredge between the piers, 2,230 cubic yards were dredged in river to re-imburse the city for dredging the same quantity from the channel in July, 1888. Two thousand two hundred and sixty cubic yards were also removed from shoal places in the river, the cost of the latter being paid by the city of Manitowoc and private parties.

Under contract dated November 1, 1888, with Messrs. Truman and Cooper, of Manitowoc, Wis., for rebuilding 400 linear feet, more or less, of the south pier above the water line, work began May 1, 1889; 401 linear feet were completed May 31, 1889, and the contract closed.

Remarks and recommendations.—The north pier was completed in 1885 and the south pier in 1887. There being no outer bar, further pier extension is unnecessary. No additional estimate is deemed necessary at present, as the estimated amount required for the completion of the existing project ($8,362.45) will probably be sufficient to rebuild the decayed superstructure.

This is one of the most important harbors on the west shore of Lake Michigan north of Milwaukee. A large number of vessels annually

seek shelter here from storms, while many also come to avail themselves of the advantages afforded by the ship-yards and dry-dock.

Should an appropriation be made for the fiscal year ending June 30, 1891, it is contemplated to expend it in rebuilding the inner ends of the piers, which are decayed above the water line.

Estimated cost (see Report of Chief of Engineers for 1891, page 2094)...	$308.182.54
Appropriated	299,820.00

Money statement.

July 1, 1888, amount available	$488.85
Amount appropriated by act of August 11, 1888	8,000.00
	8,488.85
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	7,515.74
July 1, 1889, balance available	973.11
Amount (estimated) required for completion of existing project	8,000.00
Amount that can profitably be expended in fiscal year ending June 30, 1891	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

List of materials and labor used at Manitowoc Harbor, Wisconsin, under contract dated November 1, 1888, with Messrs. Truman & Cooper, for rebuilding 401 linear feet of the south pier above the water-line.

Articles.	Quantity.	Price.	Amount.
Pine timber, 12 inches by 12 inches, framed ..... linear feet..	6,266.5	$0.30	$1,879.95
Pine plank, 3 inches by 12 inches laid ..... feet, B. M..	10,122	20.00	202.44
Drift-bolts ..... pounds..	4,763.7	.03	142.91
Wrought spikes..... do....	412	.04	16.48
Stone ..... cords..	76.2	5.75	438.15
Total	.....	.....	2,679.93

Cost per linear foot, $6.68⅛.

Abstract of proposals for cutting down and rebuilding 400 feet of superstructure, south pier, Manitowoc Harbor, Wisconsin, received in response to advertisement dated September 20, 1888.

[Opened October 22, 1888, by Maj. Charles E. L. B. Davis, Corps of Engineers.]

		White pine timber (6,750 linear feet), per linear foot.	Pine plank (3,840 feet, B. M.), per 1,000.	Stone (120 cords), per cord.	Wrought-iron drift-bolts (10,700 lbs.), per pound.	Wrought-iron spikes (200 pounds), per pound.	Total.
1	Charles Berner, Green Bay, Wis	$0.30	$16.00	$6.00	$0.03½	$0.03½	$3,187.94
2	Horatio Truman and George Cooper, Manitowoc, Wis	0.30	20.00	5.75	.03	.04	3,120.80
3	Christopher H. Starke, Milwaukee, Wis.....	0.35	25.00	7.00	.04	.05	3,736.50

With the approval of the Chief of Engineers, a contract was entered into November 1, 1888, with Truman & Cooper, the lowest responsible bidders, for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1888.

[Furnished by Charles A. Knudson.]

Name of harbor, Manitowoc, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Manitowoc, Wis.

The following table, compiled from reports furnished by the deputy collector of customs at Manitowoc, shows the arrivals, departures, and tonnage of vessels at that harbor since 1885:

Year.	Description.	Arrivals.		Departures.	
		Number.	Tonnage.	Number.	Tonnage.
1885	Steam and sail	665	204,069	670	202,[illegible]
1886	Steam	342	148,785	352	148,[illegible]
	Sail	214	27,787	221	27,[illegible]
	Total	556	176,572	573	177,[illegible]
1887	Steam	422	170,564	424	170,[illegible]
	Sail	252	41,378	254	41,[illegible]
	Total	674	211,942	678	211,[illegible]
1888	Steam	396	165,446	394	165,[illegible]
	Sail	218	37,485	220	38,[illegible]
	Total	613	202,931	614	205,[illegible]

Principal articles of import and export.

EXPORTS.

Apples	barrels	840	Live stock	head	147
Beans	bushels	100	Malt	pounds	1,151,250
Brick		1,033,000	Mill-stuffs	tons	1,100
Butter	pounds	25,000	Oats	bushels	42,250
Corn	bushels	1,195	Peas	do	111,375
Cheese	pounds	1,171,300	Plaster, land	tons	20
Eggs	dozen	102,780	Potatoes	bushels	3,175
Flour	barrels	18,260	Posts, fence	number	2,000
Hay	tons	1,700	Ties, railroad	do	22,700
Lime	barrels	161	Wheat	bushels	22,150
Lumber	feet, B. M.	100,000			

Total approximate value, $500,000.

IMPORTS.

Apples	barrels	236	Oats	bushels	800
Barley	bushels	850	Oil	barrels	255
Beer and liquor	barrels	25	Plaster, rock	tons	1,250
Coal	tons	57,526	Provisions	pounds	10,000
Corn	bushels	1,475	Salt	barrels	7,000
Hay	tons	73	Shingles		1,650,000
Iron and steel	pounds	3,014,400	Saw-logs	feet, B. M.	4,000,000
Lumber	feet, B. M.	2,488,000	Wheat	bushels	3,250
Lath		182,000	Wood and slabs	cords	3,172

Total approximate value, $650,000.

I I 12.

IMPROVEMENT OF SHEBOYGAN HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into the harbor of Sheboygan at the mouth of the Sheboygan River.

Project.—The project for the improvement of this harbor was adopted in 1852, and had for its object the formation of a 12-foot channel entrance to the mouth of the Sheboygan River. This was modified in 1873 so as to secure a deeper channel by further pier extension and dredging. Both projects were completed within their estimated cost, and a channel was formed 100 feet wide, with a depth of 15 to 16 feet beween the piers. A survey made in 1880 showed a depth of less than 12 feet between the piers and on the outer bar. The existing project was adopted in 1881, its object being to deepen the channel still further, by extending the piers to the 20-foot contour in the lake and dredging to a depth of 18 feet between their outer ends, the depth decreasing to 14 feet at the shore-line.

Present works.—Pile and crib piers. (1) North pier, 2,044 feet long, built by the city, from 12 to 20 feet wide; 1,094 feet of cribs 20 feet wide, and 50 feet of cribs 30 feet wide. (2) South pier, 2,260 feet long, composed of 780 feet of pile and crib pier, built by the city, from 12 to 20 feet wide; 132 feet of pile-pier 20 feet wide, 1,298 feet of cribs 20 feet wide, and 50 feet of cribs 30 feet wide, built 1852–1887. About 700 feet of each pier built since 1871 is in good condition, the cribs having been sunk on a stone or pile foundation. Previous to 1871 they were sunk on the natural lake bottom, composed of shifting sand, and causing them to settle very unevenly.

Depth of water.—Originally 4 feet. Soundings made in April, 1889, showed a depth of but 11½ feet in the shoalest place. The excavation of a navigable channel 14 feet in depth began May 11, 1889, and was completed June 19, 1889.

Operations during the fiscal year.—Under contract dated November 1, 1888, with Messrs. Truman and Cooper, of Manitowoc, Wis., for the construction of four cribs, each 50 by 20 by 18½ feet, including superstructure, for the extension of the south pier 200 feet, work began June 5, 1889, and is in progress.

By hired labor and the use of a United States dredge 20,150 cubic yards of material were removed from the channel. The dredging began May 11, and was completed June 19, 1889.

Remarks and recommendations.—As stated in previous reports, dredging affords but temporary relief, as, owing to the open character of the old crib-pier, large quantities of sand pass through the piers and are deposited as a bar near the entrance.

This bar has been a great impediment to commerce, and it is thought that no permanent improvement can be obtained until the piers have been extended over the bar into deep water. It may also be necessary to render the older portion of the piers sand-tight by means of some kind of revetment. In view of the above facts a sufficient amount of money should be made available to permit the rapid extension of the piers.

The local commerce is large, and this harbor would be extensively sought for shelter if the depth was sufficiently permanent for vessels to rely upon.

Should an appropriation be made for the fiscal year ending June 30, 1891, it is proposed to expend it in pier extension and such dredging

and repairs as may be necessary for the maintenance of the channel and piers. An appropriation of $50,000 is recommended.

Estimated cost (see Report of Chief of Engineers, 1881, page 2104)	$150,000
Additional estimate (see Report of Chief of Engineers, 1884, page 1856)	45,000
Total	195,000
Appropriated	113,000

Money statement.

July 1, 1888, amount available		$639.35
Amount appropriated by act of August 11, 1888		15,000.00
		15,639.35
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$2,011.50	
July 1, 1889, amount covered by existing contracts	11,000.00	
		13,011.50
July 1, 1889, balance available		2,617.85
Amount (estimated) required for completion of existing project		$2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for 200 feet pier extension, south pier, Sheboygan Harbor, Wisconsin, received in response to advertisement dated September 20, 1888.

[Opened October 22, 1888, by Maj. Chas. E. L. B. Davis, Corps of Engineers.]

	1. F. M. Knapp and E. Gillen, Racine, Wis.	2. Charles Berne, Green Bay, Wis.	3. Horatio Truman and George Cooper, Manitowoc, Wis.	4. Christopher H. Stark, Milwaukee, Wis.
Pine timber, 12 by 18 and 12 by 12 inches (9,500 linear feet), per linear foot	$0.27	$0.30	$0.28	$0.35
Hemlock timber, 12 by 18 and 12 by 12 inches (9,700 linear feet), per linear foot	.23½	.24	.22	.30
Pine plank (12,000 feet, B. M.), per 1,000	15.50	17.00	18.00	25.00
Stone (700 cords), per cord	6.75	6.50	5.75	7.00
Wrought-iron drift-bolts (15,500 pounds), per pound	.03	.03½	.03	.04
Wrought-iron screw-bolts (4,400 pounds), per pound	.04	.04½	.04	.05
Wrought-iron spikes (490 pounds), per pound	.04	.04	.04	.05
Piles (96 piles), each	10.50	9.00	9.00	15.00
Total	11,423.50	11,556.10	10,656.60	13,739.50

With the approval of the Chief of Engineers, a contract was entered into November 2, 1888, with Truman & Cooper, the lowest responsible bidders for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1888.

[Furnished by Paul Krez, deputy collector of customs.]

Name of harbor, Sheboygan, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Sheboygan, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	499	238,629	499	238,629
Sail	659	65,087	656	63,853
Total	1,158	303,716	1,155	302,482

Principal articles of export and import.

EXPORTS.

Corn	bushels..	8,000	Mill-stuffs	tons..	500
Flour	barrels..	2,000	Oats	bushels..	40,000
Hay	tons..	400	Plaster, land	tons..	2,500

IMPORTS.

Bark	cords..	2,000	Plaster, rock	tons..	2,021
Coal	tons..	32,000	Salt	barrels..	10,000
Lumber	feet, B. M..	36,000,000	Shingles	number..	6,000,000
Laths	number..	5,000,000	Wood	cords..	36,000

NOTE.—Mr. Krez states that the statistics of exports and imports are incomplete, the business transacted by the steam-boats being entirely omitted.

I I 13.

IMPROVEMENT OF PORT WASHINGTON HARBOR, WISCONSIN.

Object.—To secure a navigable channel entrance from Lake Michigan to a small artificial harbor formed by excavating two interior connected basins.

Project.—The original project for the improvement of this harbor was adopted in 1869, and provided for the building of two parallel piers extending from the shore-line to 10 feet of water in the lake, and the excavation of a basin 600 feet long by 200 feet wide inside of the shore-line. In 1870 a deflection of about 10 degrees to the southward was made in the direction of the piers, this being considered a more favorable direction for their alignment. In 1876 a further modification of the plan was made by excavating a second basin to the northward and nearly at right angles to the first basin, and extending the piers to the 14-foot contour in the lake. This doubled the available area of the harbor and reduced the height of the entering waves very materially.

This is the project now being carried out. The two interior basins have a combined area of about 5¾ acres and are to be dredged to a depth of 12 feet, with a channel of the same depth connecting them with the lake, the channel inclosed between two piers 150 feet apart and extending out to 14 feet of water.

Present works.—(1) North pier, 920 feet long, composed of 370 feet of cribs 14 feet wide; 500 feet, 20 feet wide, and 50 feet, 24 feet wide. (2) South pier, 1,226 feet long, composed of 370 feet of cribs, 14 feet wide; 450 feet, 20 feet wide, and 406 feet of pile revetment. The piers were built 1871–1887 and are in fair condition.

Depth of water.—At the mouth of Sauk River originally about 1 foot. Soundings made in May, 1889, show a navigable channel between the

piers of 10 feet in depth, and an average depth of about 9 feet in the north basin and 8 feet in the west basin.

Operations during the fiscal year.—By hired labor and the use of United States Dredge No. 2, dredging began June 22, 1889, and to June 30, the close of the fiscal year, 3,510 cubic yards of material were removed.

Remarks and recommendations.—No further extension of the north pier is contemplated.

To complete the project the south pier should be extended 100 feet and about 60,000 cubic yards of material removed by dredging. This will meet the present and prospective demands of commerce.

Cribs Nos. 8 and 9 of the north pier require additional stone filling and planking.

The piers being short and the lake bottom hard the probable cost of maintenance will be small.

Eighty-five and three-fourths per cent. of the dredging is completed, and 95.5 per cent. of the pier construction.

The funds available are probably sufficient to complete the dredging.

Should an appropriation be made for the fiscal year ending June 30, 1891, it is contemplated to expend it in completing the south pier and maintenance of the works. An appropriation of $7,000 is recommended.

Estimated cost (see Report of Chief of Engineers, 1877, page 866)	$154,527.17
Additional estimate (Report of Chief of Engineers, 1880, page 1922)	27,000.00
	181,527.17
Appropriated	174,500.00

Money statement.

July 1, 1888, amount available	$1,039.37
Amount appropriated by act of August 11, 1888	5,000.00
	6,039.37
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	693.01
July 1, 1889, balance available	5,346.36
Amount (estimated) required for completion of existing project	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	7,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1888.

[Furnished by James McCarthy, harbor-master.]

Name of harbor, Port Washington, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Port Washington, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	21	3,800	21	3,800
Sail	173	13,810	173	13,810
Total	194	17,610	194	17,610

Principal articles of export and import.

EXPORTS.

Apples	barrels	600	Lath	number	1,200,000
Barley	bushels	20,000	Leather	pounds	700,000
Beans	do	1,000	Lumber	feet, B. M.	5,000,000
Beer	barrels	1,200	Merchandise, general	tons	1,100
Brick	number	1,200,000	Malt	pounds	625,000
Butter	pounds	100,000	Mill-stuffs	tons	6,000
Chairs	number	5,000	Oats	bushels	7,000
Corn	bushels	8,000	Peas	do	2,500
Cheese	pounds	180,000	Pork	barrels	50
Eggs	dozen	100,000	Provisions	pounds	50,000
Fish	pounds	4,000	Potatoes	bushels	20,000
Furniture	pieces	80,000	Shingles	number	3,000,000
Hay	tons	300	Wheat	bushels	7,000

Total approximate value, $1,070,600.

IMPORTS.

Apples	barrels	500	Lumber	feet, B. M.	5,500,000
Bark	cords	1,600	Laths	number	1,300,000
Barley	bushels	140,000	Lime	barrels	1,000
Beer and liquors	barrels	500	Merchandise, general	tons	900
Coal	tons	3,000	Oil	barrels	1,000
Corn	bushels	10,000	Plaster, rock	tons	30
Flour	barrels	200	Provisions	pounds	200,000
Hides	pounds	1,500,000	Salt	barrels	3,000
Hay	tons	400	Shingles	number	3,000,000
Iron and steel	pounds	100,000	Wheat	bushels	5,000
Iron ore	tons	1,500	Wood	cords	300

Total approximate value, $803,400.

II 14.

HARBOR OF REFUGE AT MILWAUKEE BAY, WISCONSIN.

Object.—To provide a secure anchorage for vessels engaged in the general commerce of the lakes, by inclosing the northern section of Milwaukee Bay within a breakwater formed of timber crib-work placed and sunk upon a foundation of stone.

Project.—The project was adopted in 1881, and provided for the construction of a breakwater, the north arm of which commences at a distance of about 600 feet from the north shore of the bay in a depth of 8 feet of water. Its direction is S. 25° 19′ E., and its length 2,450 feet. From this point the direction of the main arm of the breakwater is changed to S. 11° 00′ W. for the proposed distance of 5,200 feet, with an opening of 400 feet at a distance of 1,000 feet from the angle, to provide a fair weather entrance and exit for vessels.

Present works.—The north arm of the breakwater is completed. The northern section of it, 600 feet in length, is composed of 6 cribs, each 100 feet long and 20 feet wide, and the remaining 1,850 feet of 37 cribs, each 50 feet long by 24 feet wide.

The dimensions of the cribs forming the main arm are 50 feet by 24 feet by 22½ feet. Nine hundred feet of this arm to the northward of the opening has been constructed, upon which 650 feet of superstructure has been built to a height of 6 feet above datum, and two cribs (Nos. 63 and 64), each 100 feet by 24 feet by 22½ feet, have been sunk to the southward of the opening.

Depth of water.—The slope of the lake-bed from the northern end of the breakwater to the angle formed by the north and main arms is 0.87 feet to 100 feet, the angle crib being set in 29.4 feet of water. The average depth of water on the line of section of main arm to the southward of the opening is 34.615 feet.

Operations during the fiscal year.—The act of Congress of August 11, 1888, having appropriated $70,000 for continuing this improvement, a contract, dated November 12, 1888, was entered into with Christopher H. Starke, of Milwaukee, Wis., for the construction of 400 feet, more or less, of breakwater extension.

One crib (No. 61), of dimensions 50 feet by 24 feet by 22½ feet, has been sunk in position upon a stone foundation on the main arm 100 feet to the northward of the opening, and two cribs (Nos. 63 and 64), each 100 feet long, have been sunk to the southward of the opening.

Under contract with the owner, the scow *Dunham* has been maintained as a light-ship at the southern end of the breakwater during the season of navigation.

Remarks and recommendations.—The distance from the southern extremity of the work done under previous contracts to the opening of 400 feet for fair-weather entrance and exit was 150 feet. For future work it has been considered expedient to increase the lengths of the cribs to 100 feet, and as the distance from the southern extremity of the work done under previous contracts to the opening was but 150 feet, a crib (No. 61) 50 feet in length was built and sunk, in order that the remaining 100 feet should be in one crib. As a precautionary measure it has been considered advisable to construct at least 400 feet in length of the main arm to the southward of the opening, in order to resist any forces of wave and ice to which this isolated section may be subjected. The construction and sinking of the last crib to the northward of the 400 feet opening (No. 62) will therefore be deferred until the 400 feet to the southward of the opening is secured.

Capt. W. L. Marshall, Corps of Engineers, United States Army, while in charge of this work, submitted a project, under date of March 7, 1887, for building a permanent superstructure of piers for lake harbor works, consisting of concrete faced with cast-iron plates.

This project was referred to the Board of Engineers at New York, which gave as its opinion that it would be well to construct about 250 feet in length in the most exposed part of the breakwater as an experiment. (See Appendix H H, Annual Report of the Chief of Engineers for 1887.)

This recommendation of the Board having been concurred in by the Chief of Engineers in the project for the expenditure of the funds appropriated for the harbor of refuge, it was proposed to build 200 feet of iron-faced concrete superstructure of the approved plan. This was at first approved by the Chief of Engineers, but subsequently modified, and directions given to submit a plan and estimate based upon a study of the concrete superstructure used at Buffalo, N. Y.

After a careful study of this plan a report was submitted and a recommendation made that the execution of the concrete superstructure be suspended and the work continued according to the plan previously followed, which recommendation was approved.

The correspondence relating to this subject is herewith subjoined.

Money statement.

July 1, 1888, amount available		$3,638.23
Amount appropriated by act of August 11, 1888		70,000.00
		73,638.23
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$30,249.88	
July 1, 1889, amount covered by existing contracts	37,155.11	
		67,404.99
July 1, 1889, balance available		6,233.24

Amount (estimated) required for completion of existing project.....$418,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891 200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for construction of 400 feet breakwater, harbor of refuge at Milwaukee Bay, Wisconsin.

[Received in response to advertisement dated October 1, 1888, and opened October 31, 1888, by Maj. Charles E. L. B. Davis, Corps of Engineers.]

	1. Truman & Cooper, Manitowoc, Wis.	2. Hiero B. Heir & Co., Chicago, Ill.	3. Christopher H. Starke, Milwaukee, Wis.	4. Charles Berner, Green Bay, Wis.	5. Knapp & Gillin, Racine, Wis.
Pine timber, 561,360 feet, B. M., per 1,000	$17.00	$19.00	$15.00	$16.00	$16.75
Pine plank, 25,000 feet, B. M., per 1,000	15.00	16.00	14.00	16.00	13.50
Pine 1-inch boards in work, 2,100 feet, B. M., per 1,000	19.00	14.00	20.00	20.00	15.00
Iron drift-bolts, 57,800 pounds, per pound	.03½	.04	.03	.03½	.03
Iron screw-bolts, nuts, and washers, 1,250 pounds, per pound	.06	.05	.04	.05	.04½
Iron spikes, 2,000 pounds, per pound	.05	.05	.04	.04	.04½
Stone, 4,100 cords, per cord	7.50	8.25	7.00	8.00	7.40
Framing timber, including placing, sinking, filling cribs, etc., 561,360 feet, B. M., per 1,000	8.00	8.50	8.00	8.00	7.25
Laying plank 25,800 feet, B. M., per 1,000	6.00	7.00	5.00	4.00	5.00
Taking up plank	6.00	.....	5.00	4.00	5.00
Total	47,546.90	52,341.30	43,992.28	43,980.14	46,186.89

With approval of the Chief of Engineers, a contract was entered into November 12, 1888, with Christopher H. Starke, the lowest responsible bidder for this work.

COMMERCIAL STATISTICS.

The nearest collection district is Milwaukee, Wis.; the nearest port of entry is Milwaukee, Wis. Amount of revenue collected during the calendar year ending December 31, 1888, is $291,492.63.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., September 1, 1888.

MAJOR: After approving your project for harbor of refuge at Milwaukee, with certain modifications, as set forth in yesterday's indorsement, the Chief of Engineers concluded that he would modify the experimental portion of the work of 200 feet of concrete and iron superstructure by omitting the iron, the experiment in Buffalo of concrete alone having so far worked very satisfactorily.

The Chief of Engineers therefore directs that you suspend the project for superstructure and submit a plan and estimate based upon a study of the concrete superstructure used at Buffalo, N. Y., by Captain

Mahan, with whom you will please correspond with a view to obtaining from him full plans, specifications, and such other information as he may have.

Very respectfully, your obedient servant,

CLINTON B. SEARS,
Captain of Engineers, U. S. A.,
In Charge of Office.

Maj. CHAS. E. L. B. DAVIS,
Corps of Engineers, U. S. A.

LETTER OF MAJOR CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS.

U. S. ENGINEER OFFICE,
Milwaukee, Wis., December 19, 1888.

SIR: In accordance with instructions contained in Department letter of September 1, 1888, I have the honor to submit the following plan and estimate for building 200 feet of superstructure of the breakwater of the harbor of refuge at Milwaukee, Wis., said plan being based upon a study of the concrete superstructure used at Buffalo, N. Y.

I transmit herewith a tracing showing a cross-section of the crib breakwater with the stone foundation and the proposed concrete superstructure. The superstructure is designed to correspond, as nearly as the dimensions of the crib would allow, with the design adopted for the Buffalo breakwater, the "No. 2," of the report of the Board of Engineers of February 2, 1887. The approved project for the Milwaukee Harbor of Refuge fixed the height of the superstructure at 6 feet, and experience so far having proved that height to be sufficient, I have kept the concrete superstructure at the same height.

The dimensions are shown on the tracing. The area of cross-section is 141.42 square feet or 5.23 cubic yards per running foot. The outer exposed portion for 2 feet is made of Portland cement and the rest of the common domestic variety. (The shading on the tracing should not extend across the top of the crib.)

Captain Mahan furnished me with very full and accurate figures of the amount of materials and cost of labor of the work at Buffalo. The cost of a cubic yard at the local prices here would be for the face, $8.32, and for the backing, $6.02. This would make the cost per running foot, $36.90. This is merely the cost of the materials and labor, and does not include the cost of plant, hire of tugs, etc., items which foot up some $10,000 at Buffalo.

The amount of work to be done is so small it will not pay to purchase any plant, so the concrete will have to be mixed by hand and the necessary barges, etc., hired by the month. This will increase the cost considerably, and I think it safe to estimate contingencies at 20 per cent., or $44.18 per running foot. The work being experimental should be done by hired labor and not by contract.

The plan submitted by Captain Marshall, and at first approved by the Department, consisted of cast-iron plates filled in between with concrete. On account of the plates holding the concrete in position, the latter could be made of cheaper materials than that called for by the Board's plan, and in Captain Marshall's opinion his plan was considerably cheaper than that of the Board.

The Department letter of September 1, 1888, states that the experiment at Buffalo has so far worked satisfactorily. It is questionable,

therefore, in my mind, whether it is worth while repeating the same experiment here.

In the reports on permanent superstructure I find constant reference to "the increasing scarcity and cost of timber," but the records in this vicinity do not show any great increase of cost.

The following table shows this very clearly:

Contract prices per 1,000 feet, B. M., for 12 by 12 inch pine timber at Milwaukee and Racine, Wis.

Year.	Milwaukee.	Racine.	Year.	Milwaukee.	Racine.
1867	.....	$20.00	1881	$19.00	$19.75
1871	$16.08	15.00	1882	19.50	.....
1872	16.08	.....	1883	19.50	.....
1874	.....	16.67	1884	14.50	16.50
1876	.....	*30.00	1885	14.50	.....
1877	†25.00	.....	1886	15.00	16.00
1879	.....	13.50	1887	15.00	.....
1880	.....	16.00	1888	15.00	.....

* Framed and bolted in the work.
† Includes framing; about $16.50 would be the value of the timber.

These tables show that for the last twenty years the price of timber has not very materially increased; and, although it would be rash to prophesy that no material increase may be looked for in the next twenty years, certainly the price has not yet reached a figure to warrant the increased cost of a permanent superstructure.

The average annual appropriation has been $83,000, and counting in 1883 and 1885, when there was no river and harbor bill, the average for eight years has been $51,850, so that it will take over eight years to complete the present project at this rate, the amount required to complete the project being $418,600.

As the harbor is much sought by sailing craft as a harbor of refuge even in its present incomplete state, and as each additional crib sunk increases its capacity as a harbor of refuge, I urgently recommend the continuance of the present project until the completion of the work.

Afterwards, as the portions above water rot away and the cribs reach their final settlement, the superstructure can be replaced by some permanent structure, and by that time the Buffalo work will have passed beyond the experimental stage and will furnish ample data for the Milwaukee work.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Col. O. M. POE,
Corps of Engineers, U. S. A.,
Division Engineer of the Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., December 21, 1888.

Respectfully forwarded to the office of the Chief of Engineers with the following remarks:

In my estimation, the most important question now outstanding with regard to the ordinary timber structures on the lakes is to determine

the best and cheapest mode of constructing a more durable superstructure, whether as an original construction or to replace superstructures which have fallen into decay. In this connection the existing experimental works at Buffalo and Chicago have great value, but it hardly seems necessary to exactly repeat either one at another place.

Meanwhile, it is desirable that works of the character of this harbor of refuge should be pushed to completion under the old designs, rather than subject them to the delays which would probably result from an endeavor, with insufficient annual appropriations, to build the superstructure of more durable materials.

Therefore, upon the supposition that the matter is open for consideration, I recommend that the execution of the concrete superstructure be suspended for the time being, and that the work proceed according to the plans heretofore followed.

If, however, the question of the immediate use of a concrete superstructure has been decided, I then recommend approval of the design submitted by Major Davis.

O. M. POE,
Colonel of Engineers,
Engineer N. W. Division.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 28, 1888.

Respectfully returned to Maj. Chas. E. L. B. Davis, Corps of Engineers (through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division), whose recommendation that the present project be continued until the completion of the work is, for the reasons given, approved.

By command of Brig. Gen. Casey.

JAS. C. POST,
Major of Engineers.

[Third indorsement.]

U. S. ENGINEERS OFFICE,
Detroit, Mich., December 31, 1888.

Respectfully transmitted.

O. M. POE,
Colonel of Engineers,
Engineer N. W. Division.

II 15.

IMPROVEMENT OF MILWAUKEE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the Milwaukee River, which is the interior harbor of Milwaukee.

Project.—The original project adopted in 1852 provided for the formation of a channel 260 feet wide and 12 feet deep, by dredging across the point which overlapped the mouth of the Milwaukee River at the distance of 3,000 feet to the northward of its original outlet, and by the

construction of parallel piers of crib-work, each 1,120 feet in length, for the protection of the sides of the channel thus formed. In 1868 an extension of the piers became necessary for the requirements of commerce, and, under a continuation of the original project, both the north and south piers were extended 600 feet into the lake to 18 feet depth of water.

Present works.—The entire length of the channel between the piers is 1,740 feet; its width at the outer end has been increased through the outward settling of cribs to 284 feet. The width of each of the 1,120-foot sections of piers first built is 20 feet. The pier extensions of 600 feet in length are 26 feet wide, excepting the pier-heads, which are each 30 feet wide and 50 feet long, protected by a bulkhead of piles and oak timbers.

The superstructure of the inner section of the north pier for 1,052.6 feet of its length, by 20 feet in width, is of quarry-faced dry stone masonry, the side walls being 4 feet thick. Between these walls for a length of 663 feet the filling is of stone packed with gravel, and covered with large paving stones of 9 inches in thickness. The filling between walls for the remaining 389.6 feet is of packed stone with a top layer of concrete pavement of 9 inches in thickness. Piles for the protection of the piers have been driven along the channel faces. The superstructure over the pier extensions of the 600 feet was built in 1871 and 1872. In 1887 the superstructure of the 600 feet extension of the north pier was cut down and rebuilt.

Depth of water.—No dredging has been done in the channel between the piers at this harbor since 1880, in which year excavation was made to a depth of 18 feet, and to a width of 200 feet throughout its entire length. A plat of the soundings taken on the 18th day of April, 1889, shows that a narrow channel of 17 feet in depth is still available for navigation, and one of 16 feet in depth, with a least width of 100 feet.

Operations during the fiscal year.—On March 21, 1889, a contract was entered into with W. T. Casgrain, of Milwaukee, Wis., for rebuilding 400 feet, more or less, of the superstructure of the outer section of the south pier. At the close of the fiscal year 340 feet had been completed.

Remarks and recommendations.—The stone superstructure of the north pier is in fair condition, but the effect of the ice which is formed in the joints between the blocks of stone is very noticeable. When first laid, the stones were placed in as close contact as the nature of the partial dressing would admit of, but each year the force of the ice pressure increases the widths of the joints, so that in some instances the spaces between the blocks are fully 1½ inches wide. The concrete pavement between side walls is much worn and in need of renewal. Its impaired condition is due to various causes, the chief of which are the effects of frost, erosion by waves, attrition by the constant passing of pedestrians, and the wave force applied from below the water surface during heavy storms. At the west or inner end of each pier repairs are much needed, and the pile protection to the stone superstructure needs to be renewed. The depth of the channel for its entire length should be increased to 18 feet, and to a width of 200 feet by dredging. The excavation necessary to effect this, by computations made from soundings taken April 18, 1889, is 30,468 cubic yards.

An estimate of the cost of these improvements is as follows:

For 200 linear feet of superstructure of outer section of south pier, at $20.	$4,000.00
30,468 cubic yards of dredging, at 20 cents	6,093.60
150 linear feet of repairs at west end of north pier, at $12	1,800.00
100 linear feet of repairs at west end of south pier, at $14	1,400.00

264 white oak piles, each 32 feet long, driven and secured in place, for protection of stone superstructure of north pier, at $9.60 each	$2,534.40
14,000 feet B. M. of oak wale timber, at $45 per M	630.00
3,000 pounds screw-bolts, at 4 cents	120.00
	$16,578.00
Add 10 per cent. for contingencies	1,657.80
	$18,235.80

The funds asked for the fiscal year ending June 30, 1891, are to be applied to the work above mentioned.

Money statement.

Amount appropriated by act of August 11, 1888		$10,000.00
July 1, 1889, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1888	$4,517.79	
July 1, 1889, amount covered by existing contracts	4,155.87	
		8,673.66
July 1, 1889, balance available		1,326.34
Amount (estimated) required for completion of existing project		20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for cutting down and rebuilding 400 feet of superstructure, south pier, Milwaukee Harbor, Wisconsin.

Received in response to advertisement dated January 21, 1889, and opened February 27, 1889, by Maj. Charles E. L. D. Davis, Corps of Engineers.]

	1. Hiero B. Herr & Co., Chicago, Ill.	2. Knapp & Gillen, Racine, Wis.	3. Christopher H. Starke, Milwaukee, Wis.	4. W. T. Casgrain, Milwaukee, Wis.
Pine timber, 160,400 feet B. M., per 1,000	$19.00	$18.00	$16.00	$18.00
Pine plank, 6,000 feet B. M., per 1,000	16.00	14.00	14.00	16.00
Iron drift-bolts, 18,400 pounds, per pound	.04	.03½	.03	.03
Iron screw bolts, nuts, and washers, 4,000 pounds, per pound	.05	.05	.05	.04
Iron spikes, 550 pounds, per pound	.05	.05	.05	.04
Oak timber, in place, 6,000 feet B. M., per M	45.00	50.00	45.00	45.00
Oak piles, driven and secured in the work, 2,800 linear feet, per linear foot	.35	.35	.32	.30
Laying and securing plank in work, per M feet, B. M., used	5.00	5.00	6.00	5.00
Framing, including all labor involved, per M feet, B. M., used	18.00	18.00	18.00	15.00
Taking out and removing old protection piles, per piece	4.00	6.00	4.50	5.00
Total	8,268.30	8,039.90	7,519.10	7,363.30

With approval of the Chief of Engineers, contract was entered into March 21, 1889, with W. T. Casgrain, the lowest responsible bidder, for this work.

Commercial statistics for the calendar year 1888.

Name of harbor, Milwaukee, Wis.; collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee, Wis. Amount of revenue collected during year, $291,492.62.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
s	2,738	1,973,828	2,757	2,019,467
	2,545	485,612	2,567	499,229
Total	5,283	2,459,440	5,324	2,518,696

ıe following extracts, taken from the annual report of the secretary of the Cham- ıf Commerce for the fiscal year ending April 1, 1889, shows the receipts, shipments, manufactures of some of the leading articles of commerce at the harbor and city ilwaukee during the year:

Receipts.

Articles.	Quantity.	Articles.	Quantity.
y, by rail and lake ..... bushels..	6,465,471	Hops, used by brewers ..... pounds..	1,758,097
y, local consumption ..... do....	2,905,855	Lumber ..... feet, B. M..	312,834,000
r..... pounds..	4,201,182	Shingles..... number..	78,258,000
ıe ..... do....	17,291,149	Lath ..... do....	14,649,000
by lake..... tons..	961,164	Cedar posts..... do....	1,919,131
by railroad..... do....	161,989	Malt ..... bushels..	3,358,363
..... bushels .	1,168,190	Millstuffs ..... tons..	34,172
..... packages.	85,492	Oats..... bushels..	2,975,000
eed (billed to this market),	104,811	Pig-iron ..... tons..	37,766
hels.....	433,697	Potatoes .... bushels..	187,521
(billed to this market) barrels..	2,427,336	Salt ..... barrels..	482,346
wood ..... cords..	105,786	Tan-bark..... cords..	52,951
t..... number..	480,019	Tallow ..... pounds..	1,208,024
, manufactured into leather,		Wheat (exclusive of through move-	
aber.....	433,697	ment ..... bushels..	8,129,315
..... number..	451,339	Tobacco, Wisconsin (billed to Mil-	
..... bales..	11,002	waukee)..... pounds..	2,031,352

Shipments.

Articles.	Quantity.	Articles.	Quantity.
y..... bushels..	3,579,657	Millstuffs..... tons..	82,470
r..... pounds..	1,115,599	Oats..... bushels..	885,090
e ..... do....	12,898,076	Pig-iron ..... tons..	32,472
..... tons..	458,837	Pork, ham, beef, shoulders, and mid-	
..... bushels..	487,670	dles..... tierces..	10,338
eed ..... do....	52,428	Pork, ham, beef, shoulders, and mid-	
..... barrels..	3,410,289	dles..... barrels..	57,634
..... number..	46,322	Pork, ham, beef, shoulders, and mid-	
..... do....	25,592	dles..... boxes..	47,733
..... barrels..	1,093	Potatoes..... bushels..	31,125
..... tierces..	15,297	Salt..... barrels..	427,870
ıer..... feet, B. M..	136,289,507	Tobacco, Wisconsin ..... pounds..	896,067
..... bushels..	1,034,599	Wheat..... bushels..	2,691,076
ı, bulk ..... pounds..	18,178,743		

Manufactures.

Articles.	Quantity.	Articles.	Quantity.
and shoes..... value..	$2,000,000	Pig-iron..... tons..	59,666
..... barrels..	1,848,447	High wines..... barrels..	12,388
..... number..	60,000,000	Knit goods..... value..	$1,700,000
at, hydraulic..... barrels..	410,000	Cigars ..... number..	33,868,650
..... do....	1,421,258	Tobacco..... pounds..	5,000,682
er..... value..	$4,000,000	Tinware ..... value..	$1,000,000

Miscellaneous.

pts of office of internal revenue	$2,587,924.41
deposits	634,132,062.67
ıge of vessels owned in Milwaukee..... tons..	41,038.22

I I 16.

IMPROVEMENT OF RACINE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into Root River, at the mouth of which the city and harbor of Racine are situated.

Project.—The original project for the improvement of this harbor was made and adopted in 1842 or 1843. Its intention was to provide and maintain a channel 12 feet deep by dredging between protection piers constructed of crib-work placed parallel to each other and 160 feet apart, the distance from the shore-line to 12 feet of water in Lake Michigan being about 800 feet.

In 1866 the project was modified with a view to providing a channel of 15 feet in depth.

Under this modification the north pier has been extended 630 feet, and the south pier about 500 feet.

Present works.—The north pier is about 1,460 feet in length. Its western section of 200 feet in length is 12 feet in width; its middle section of 960 feet in length is 20 feet wide, and its outer or eastern section of 300 feet in length is 30 feet wide. The south pier is 1,070 feet in length; its inner or western section of 530 feet in length is 16 feet in width, and its outer or eastern section of 540 feet in length is 20 feet in width. The north or weather pier extends 380 feet farther into the lake than the south pier.

Depth of water.—The natural depth of water on the bar in front of the mouth of the river before artificial improvement was made was variable. The effect of a northeast storm would be to deposit sand to such an extent as to completely obstruct the entrance until an accumulated head of water in the river would be sufficient to remove the barrier, and upon a change of wind sometimes a narrow channel to a depth of 5 or 6 feet would be scoured out.

The work done under the project previous to 1860 provided a channel of from 9 to 10 feet in depth. The extension of the piers with the periodical dredging which has been done since 1866 has generally maintained a channel of from 13 to 15 feet in depth, but the maintenance of a 15-foot channel is dependent upon a frequent use of the dredge. A plot of the soundings taken June 11, 1888, showed an available channel of but 12 feet in depth.

Operations during the fiscal year.—On October 9, 1888, a contract was entered into with Christopher H. Starke, of Milwaukee, Wis., for dredging the channel to the uniform depth of 16 feet from that depth of water in Lake Michigan to the west end of the harbor piers, and for the full width of the channel, leaving a berme alongside the channel-face of each pier of 15 feet in width.

The excavation was completed in accordance with the terms of the contract on the 30th of November, 1888.

The number of cubic yards taken out by the dredge under the contract was 36,356.

Remarks and recommendations.—Soundings were taken at this harbor on May 4, 1889, a plot of which shows an extensive sand deposit to have been made during the past winter upon the bar outside of the eastern or outer extremity of the south pier, and also in the channel between the piers, but a channel of over 15 feet in depth and a minimum width of 80 feet is yet available for vessels.

The superstructure of the western section of the north pier, 200 feet in length by 12 feet in width, and 635 feet of its middle section, of 20 feet in width, is much decayed.

Three hundred and ten feet in length of the superstructure at the west end of the south pier requires renewal.

Through changes made in the direction of the piers the width of the channel, at its outer end, has been increased to 270 feet; this increase in width of more than 100 feet in the 1,070 feet of the south pier admits an increased volume of wave from the lake, which in passing through the narrower part of the channel, at its west end, causes great disturbance during easterly storms.

The river and harbor act of August 11, 1888, contained a proviso for an examination or survey, with a view to enlarging and deepening the channel at Racine Harbor.

The report of the preliminary examination, dated October 20, 1888, was forwarded, and a copy of it is inclosed in the annual report of this year of examinations and surveys in my charge.

In order to maintain a channel of 15 feet in depth, without constant dredging, it will be necessary to extend each of the piers farther into the lake. The growth of the shore accretions to the northward of the harbor channel has been large during the past two years; the shore-line, at its intersection with the north pier, when the water-surface is at zero upon the gauge, extends to within a distance of 250 feet of the west face of the light-house crib. This crib was built at the extremity of the north pier, as far as it was constructed under the original project for securing a channel of 12 feet in depth.

An extension of the north pier 300 feet in length by 24 feet in width, and of the south pier 500 feet in length by 20 feet in width, would probably prevent the constant deposit of sand at the harbor entrance. A narrowing of the channel at the harbor entrance would also lessen the disturbance which is now so troublesome in the lower reaches of the river.

An estimate of the cost of extending the piers to the above-specified distance is as follows:

For 300 running feet of crib-work in extension of the north pier, 24 feet in width, at $85	$25,500.00
For 500 running feet of crib-work in extension of the south pier, 20 feet in width, at $70	35,000.00
	60,500.00
Add 10 per cent. for contingencies	6,050.00
Total	66,550.00

Money statement.

July 1, 1888, amount available	$599.48
Amount appropriated by act of August 11, 1888	10,000.00
	10,599.48
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	6,999.53
July 1, 1889, balance available	3,599.95

Amount (estimated) required for completion of existing project	82,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for dredging 40,000 cubic yards, Racine Harbor, Wis.

[Received in response to advertisement dated September 8, 1888, and opened September 27, 1888, by Maj. Charles E. L. B. Davis, Corps of Engineers.]

No.	Name and address of bidder.	Per cubic yard.
		Cents.
1	Christopher H. Starke, Milwaukee, Wis	17
2	Green Bay Dredge and Pile Driver Company, Green Bay, Wis	20
3	Truman & Cooper, Manitowoc, Wis	24
4	Samuel O. Dixon, Racine, Wis	25
5	Frank R. Crane, Chicago, Ill	27

With approval of the Chief of Engineers, a contract was entered into October 9, 1888, with Christopher H. Starke, the lowest responsible bidder, for this work.

Commercial statistics for the calendar year 1888.

[Furnished by Secretary of Business Men's Association, Racine.]

Name of harbor, Racine, Wis.; collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	614	397,698	613	397,470
Sail	400	55,308	402	54,502
Total	1,014	453,006	1,015	451,972

Manufactures and exports.

Articles.	Quantity.	Articles.	Quantity.
Boilers, steam ..... number..	400	Oats ..... bushels..	10,000
Beer and ale ..... barrels..	17,096	Posts and railroad ties ..... number..	80,000
Brick ..... number..	8,800,000	Plows, etc ..... do....	2,750
Butter ..... pounds..	22,400	Refrigerators ..... do....	1,000
Cultivators and harrows .... number..	2,000	Steam-engines ..... do....	250
Fanning-mills ..... do....	8,150	Sleighs ..... do....	1,000
Flour ..... barrels..	30,000	Shingles ..... do....	9,000,000
General merchandise ..... tons..	11,333	Sewer-pipe ..... tons....	2,000
Horse-power and saw-mills .. number..	747	Seeders ..... number..	10,000
Horse-rakes ..... do....	500	Thrashing-machines ..... do ..	1,700
Leather ..... pounds..	293,000	Trunks, satchels etc ..... do....	226,000
Land-rollers ..... number..	225	Wagons, carriages, and carts .. do....	21,000
Lumber and laths ..... feet, B. M..	23,000,000	Wool ..... pounds..	120,000
Mill-stuffs ..... tons..	1,230	Wooden-ware ..... number..	25,000

Total approximate value, $7,238,994.

Imports.

Articles.	Quantity.	Articles.	Quantity.
Bark.....cords..	1,212	Lumber.....feet, B. M..	58,232,000
Barley.....bushels..	58,000	Laths.....number..	4,000,000
Brick.....number..	36,000	Oats.....bushels..	22,360
Coal and coke.....tons..	83,350	Oil.....barrels..	1,387
Corn.....bushels..	15,460	Railroad ties and fence posts, number.....	74,906
Goat-skins.....number..	150,000	Shingles.....number..	15,800,000
General merchandise.....tons..	52,194	Salt.....barrels..	5,837
Hides.....pounds..	730,000	Tobacco.....pounds..	31,064
Hay.....tons..	687	Wheat.....bushels..	162,780
Iron and steel.....pounds..	49,326,856	Wool.....pounds..	180,030
Live stock.....number..	100	Wood.....cords..	17,572
Leather.....pounds..	732,313		

Total approximate value, $4,255,284.

II 17.

IMPROVEMENT OF KENOSHA HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the extensive basin at the mouth of Pike Creek, upon which the city and harbor of Kenosha are situated.

Project.—The original project for the improvement of this harbor, adopted in 1852, was directed towards securing a channel 12 feet deep from 12 feet of water in Lake Michigan to the interior basin or bayou, by the construction of piers placed parallel to each other and 150 feet apart, and by dredging between them.

In 1866 a modification or extension of the original project was made, in order to provide a navigable channel 15 feet in depth.

Present works.—The north pier is 1,600 feet in length. Its inner or western section, which was built either by private parties or the city of Kenosha, is of pile-work, 365 feet in length and 12 feet in width. The adjoining section to the eastward, built under the original project of 1852, is of crib-work, 610 feet long and 18 feet wide. The extension of this pier since 1866 is 625 feet long, 250 feet of which is 30 feet wide.

The south pier is 800 feet long and 20 feet wide, commencing at the shore-line and extending into the lake.

The north pier extends 420 feet farther into the lake than the south pier.

Depth of water.—The natural depth of water at the mouth of Pike Creek before it was improved changed with each recurring easterly storm; not more than 2 or 3 feet could be depended upon at the entrance. The work first done under the project furnished a channel of from 9 to 10 feet in depth between the piers.

The extensions of the piers since 1866, together with periodical dredging, have generally provided a channel of about 12 feet in depth, but in order to maintain a greater depth of water frequent applications of the dredge have been necessary.

Operations during the fiscal year.—On October 9, 1888, a contract was entered into with Christopher H. Starke, of Milwaukee, Wis., for dredging the channel to the uniform depth of 15 feet from the outside of the bar in front of the harbor entrance to the line of the shore on the south side of the harbor, leaving a berme of 15 feet in width alongside the

channel-face of each pier. The work was completed, in accordance with the terms of the contract, on the 30th of November, 1888. The quantity of material taken out by the dredge under the contract was 24,893 cubic yards.

Remarks and recommendations.—A plot of the soundings, taken at this harbor on May 3, 1889, shows that the bar to the eastward of the extremities of the piers, which was removed by the dredge to the depth of 15 feet in October and November, 1888, has reformed across the entire front of the harbor entrance, the depth of the water upon it being from 9.8 to 13 feet. Between the piers the deposit has not been as large during the past winter as it has been in some former years. The superstructure of the north pier, which was built in 1872 and 1874, is very much decayed, and in a short time will require renewal.

The shore-line now extends beyond the extremity of the north pier, as it was built under original project for improvement.

The only effective method which can be applied at this harbor to prevent the formation of a bar at its entrance is to extend the piers to such a distance in Lake Michigan as will arrest the sand which is carried by wave action along the adjacent shore.

An estimate of the cost of extending the north pier to a distance of 300 feet and the south pier 600 feet is as follows:

For 300 running feet of crib-work in extension of the north pier, 24 feet in width, at $85	$25,500.00
For 600 running feet of crib-work in extension of the south pier, 20 feet in width, at $70	42,000.00
For cutting down and rebuilding 425 running feet of superstructure of north pier, 18 feet in width, at $10	4,250.00
For cutting down and rebuilding 365 running feet of superstructure of north pier, 12 feet in width, at $8.50	3,102.50
	74,852.50
Add 10 per cent. for contingencies	7,485.25
Making a total amount now estimated as necessary for the existing project of this harbor	82,000.00

The river and harbor act of August 11, 1888, contained a proviso for an examination or survey of Kenosha Harbor for a harbor of refuge.

The report of the preliminary examination, dated October 20, 1888, was forwarded, and a copy of it is inclosed in the annual report of this year for examinations and surveys in my charge.

Money statement.

July 1, 1888, amount available	$799.93
Amount appropriated by act of August 11, 1888	7,500.00
	8,299.93
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	5,443.07
July 1, 1889, balance available	2,856.86
Amount (estimated) required for completion of existing project	82,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for dredging 25,000 cubic yards, Kenosha Harbor, Wisconsin.

[Received in response to advertisement dated September 8, 1888, and opened September 27, 1888, by Maj. Charles E. L. B. Davis, Corps of Engineers.]

No.	Name and address of bidder.	Per cubic yard.
		Cents.
1	Frank R. Crane, Chicago, Ill.	26
2	Samuel O. Dixon, Racine, Wis	25
3	Knapp & Gillen, Racine, Wis	26
4	Truman & Cooper, Manitowoc, Wis	25
5	Green Bay Dredge and Pile Driver Company, Green Bay, Wis	20
6	Christopher H. Starke, Milwaukee, Wis	19

With approval of the Chief of Engineers, a contract was entered into October 9, 1888, with Christopher H. Starke, the lowest responsible bidder for this work.

Commercial statistics for the calendar year 1888.

[Furnished by Henry Williams, mayor of Kenosha.]

Name of harbor, Kenosha, Wisconsin; collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee; amount of revenue collected at the nearest port of entry, $291,492.63.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	51	6,008	50	5,996
Sail	163	22,705	162	22,119
Total	214	28,713	212	28,115

Principal articles of export and import.

EXPORTS.

Oats	bushels..	10,000	Gravel	yards..	7,500
Hay	tons..	2,000			

Total approximate value, $33,000.

IMPORTS.

Bark	cords..	12,000	Lumber	feet, B. M..	10,550,000
Coal	tons..	12,000	Wood	cords..	2,500

Total approximate value, $330,000.

I I 18.

IMPROVEMENT OF WAUKEGAN HARBOR, ILLINOIS.

Object.—To provide a shelter for the protection of vessels engaged in the commerce of the city of Waukegan.

Project.—In 1852 an appropriation of $15,000 was made for the "improvement of the harbor and breakwater at Waukegan, Ill." The plan adopted was a breakwater parallel to the shore in 20 feet of water. One crib, 30 feet by 25 feet, was placed in position, but was carried away by a storm and the work then abandoned. In 1872 an examination and

report were made, as called for by the river and harbor act of that year. This plan contemplated a breakwater in 24 feet of water. No action was taken on this report.

The character of the improvement of this harbor is somewhat different from that of other points on the Great Lakes. Most of the improvements have consisted in deepening the mouths of streams emptying into the lake, but at Waukegan there is only a creek emptying into the lake and it is of no importance for harbor purposes.

The present project was adopted in 1880, its intention being to construct an exterior basin of sufficient capacity to meet the requirements of the local trade by inclosing a portion of Lake Michigan within piers constructed of pile-work, and an entrance channel between piers from a depth of 12 feet of water in Lake Michigan to the basin. The channel and basin to be excavated by dredging to the depth of 12 feet.

Present works.—The length of the north pier is 1,259.6 feet; the length of the south pier is 1,024.9 feet, making a total length of pier-work of 2,284.5 feet.

The north pier, which incloses the basin, is comprised of three sections, the first of which runs easterly from inside the shore-line as it existed in 1879 for a distance of 345 feet into the lake. This section is comprised of a single row of 12 by 12 inch squared pine piles, re-enforced at the angle or outer end for a length of 80 feet with oak piles driven at a distance of 12 feet from the front row, the interior space being filled with stone ballast.

The next section of pile-work, 16 feet wide, runs in a southerly direction for a distance of 380.8 feet to the channel angle.

The outer section of 16 feet in width, which runs in an easterly direction for a distance of 533.8 feet from the channel angle into Lake Michigan, is comprised of two rows of closely-driven white oak piles, divided into sections by cross rows driven at distances of about 32 feet apart, double-sheeted with 3-inch pine plank and filled with stone ballast to a height of 2 feet above datum.

The south pier is built upon a prolongation of the line of the south side of Madison street, in the city of Waukegan. The inshore section of this pier, 140.3 feet, is comprised of a single row of square pine piles of dimensions 12 inches by 12 inches by 18 feet, with the exception of the outer 24 piles, which are 22 feet in length and 12 inches square.

The next outer section of 100 feet in length is constructed of round white oak piles, each 30 feet in length, driven on alignment at distances of 3 feet from center to center, and sheeted with two rows of planks of dimensions 3 inches by 12 inches by 22 feet, driven close and breaking joints, and spiked to the wales which inclose and secure the round piles.

The next section to the eastward of 109 feet in length is built with round white oak piles, each 30 feet long, driven at distances of 3 feet from center to center and secured with binders. On the south side of this row pine piles of 8 inches by 12 inches by 26 feet are driven in close contact and bolted to the binder and re-enforced with a pine binder of 3 by 12 inches.

The outer section of this pier, 675.6 feet in length, is comprised of two parallel rows of white oak piles of 31 feet in length, driven in close contact at distances of 14 feet from center to center of rows and divided into sections of about 32 feet each. These rows are secured and bound in place by means of wales, binders, screw-bolts, and tie-rods, in a similar manner to those of the outer section of the north pier.

On the south side of the north row a double sheeting of pine plank 3 inches by 12 inches by 22 feet is driven and spiked to the wales in a

similar manner to the second section. The interior of this section has been filled with stone ballast to a height of 2 feet above the water-surface when at datum, but in some places it has settled somewhat below that level.

In the construction of these piers it has been necessary to place a riprap of stone along the outer sides of the piles as fast as they have been driven.

Depth of water.—Before work was commenced upon this harbor, the distance from the line of shore in front of which the piers have been constructed to the natural depth of 12 feet of water in Lake Michigan, was about 870 feet, but as the work has progressed an extensive accretion has been formed to the northward of the harbor. The shore-line now intersects the north pier at a distance of 570 feet outside or to the eastward of the line of shore as it existed in 1879, and the depth of 12 feet of water is about 350 feet outside that former line of depth, or more than 1,200 feet to the eastward of the line of shore of 1879.

A large deposit of sand has also been made in the interior of the basin.

Operations during the fiscal year.—By purchase of materials in open market and hired labor, an extension of 248 feet in length was made to the south pier in 1888. This work was commenced on the 1st of September and completed on the 10th of December, with the exception of the delivery of 53 cords of stone ballast. This quantity of stone is yet due to this section of the pier, and will be placed in the same shortly.

On October 9, 1888, a contract was entered into with the Green Bay Dredge and Pile-Driver Company for dredging an entrance channel from the line of 12 feet of water in Lake Michigan to the west end of the outer section of the north pier and in the harbor basin, the length of the entrance channel being about 800 feet, and its width 120 feet. The dimensions of the basin to be 500 feet by 160 feet.

The contractors commenced dredging under this contract on the 25th of May, 1889, and up to this date have taken out 17,805 cubic yards of material.

Remarks and recommendations.—Both the north and south piers are carried beyond the line of 12 feet of water as it existed in 1879, but since their construction the accretions on the north side of the harbor have gathered to such an extent as to have materially changed the pre-existing conditions in the depth of water. The eastern extremity of the north pier extends now but 350 feet beyond the intersection of the shore-line with the pier, and the present line of 12 feet of water is at a distance of about 300 feet beyond the pier extremities.

For economical considerations, and in order to maintain a channel of 12 feet in depth into the harbor basin for a period of five years, each of the piers should be extended into the lake to a further distance of 500 feet, for the reason that under the present conditions only a constant use of the dredge will maintain a navigable channel. The unappropriated balance of $46,000 will do the necessary dredging for the proposed interior basin, but in order to extend each of the piers to a further distance of 500 feet, an additional sum of $75,000 will be required, as follows:

For 500 running feet of crib-work in extension of the north pier, 20 feet in width, at $75	$37,500
For 500 running feet of crib-work in extension of the south pier, 20 feet in width, at $75	37,500
Total	75,000

The estimated cost of $75 per running foot of pier 20 feet in width may seem excessive, but experience at this harbor has shown that it will be necessary for the stone foundations to extend down to the top of the clay formation, which, upon the lines of the proposed extensions, is at a depth of 20 feet below datum.

Money statement.

July 1, 1888, amount available		$274.80
Amount appropriated by act of August 11, 1888		25,000.00
		25,274.80
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$11,040.17	
July 1, 1889, amount covered by existing contracts	7,076.96	
		18,117.13
July 1, 1889, balance available		7,157.67
Amount (estimated) required for completion of existing project		121,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for dredging 60,000 cubic yards, Waukegan Harbor, Illinois.

[Received in response to advertisement dated September 8, 1888, and opened September 27, 1888, by Maj. Charles E. L. B. Davis Corps of Engineers.]

No.	Name and address of bidder.	Per cubic yard.
		Cents.
1	Samuel O. Dixon, Racine, Wis	17
2	Knapp & Gillen, Racine, Wis	21
3	Frank R. Crane, Chicago, Ill	22
4	Truman & Cooper Manitowoc, Wis	27
5	Green Bay Dredge and Pile Driver Company, Green Bay, Wis	12
6	Christopher H. Starke, Milwaukee, Wis	15

With approval of the Chief of Engineers, a contract was entered into October 9, 1888, with Green Bay Dredge and Pile Driver Company, the lowest responsible bidders for the work.

Commercial statistics for the calendar year 1888.

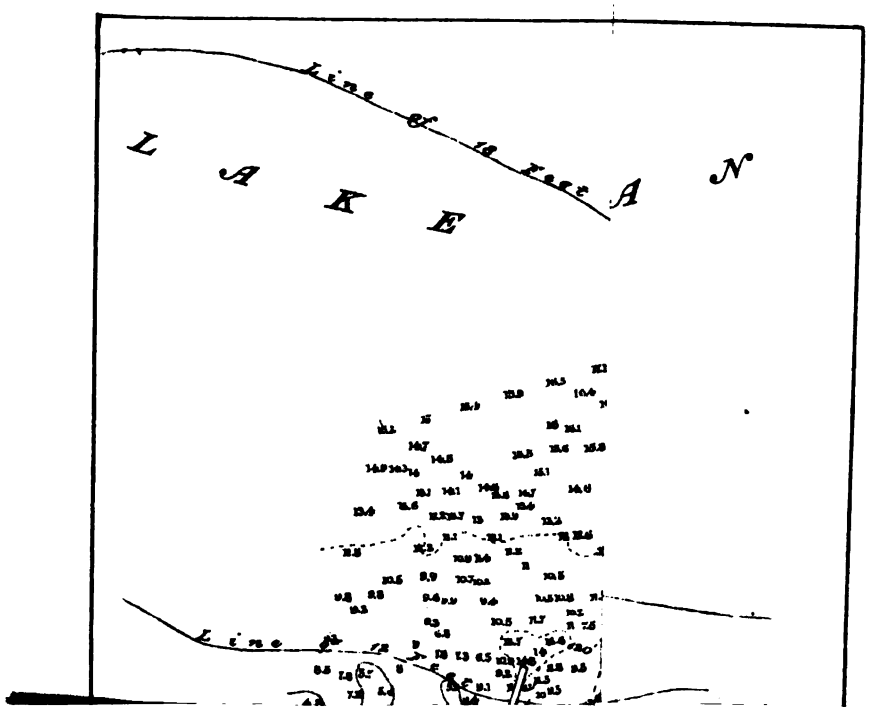
[Furnished by H. C. Hutchinson, mayor of Waukegan.]

Name of harbor, Waukegan, Ill.; collection district, Chicago, Ill.; nearest port of entry, Chicago, Ill.; nearest light-house, Waukegan, Ill.; amount of revenue collected at nearest port of entry, $4,977,389.43.

Arrivals and departures of vessels.

Description.	Arrivals.	Departures.
Steam	*34	34
Sail	*36	36
Total	70	70

* Tonnage not known.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Principal articles of export and import.

EXPORTS.

Beans	bushels	500	Leather	pounds	546,000
Beer	barrels	10,000	Lumber	feet, B. M.	300,000
Brick	number	200,000	Lumber, manufactured	cars	15
Butter	pounds	155,000	Oats	bushels	18,000
Eggs	dozen	72,000	Wool	pounds	420,000
Fish	pounds	240,000			

IMPORTS.

Apples	barrels	580	Beer and liquors	barrels	3,195
Bark	cords	460	Coal	tons	8,860
Brick	number	280,000	Corn	bushels	2,500
Flour	barrels	5,475	Hides	pounds	1,920,000
Hay	tons	350	Merchandise, general	tons	24,960
Iron and steel	pounds	504,000	Oil	barrels	1,671
Leather	do	9,900	Plaster, rock	tons	15
Eggs	dozen	55,000	Provisions	pounds	21,700
Lumber	feet, B. M.	687,000	Salt	barrels	2,270
Lath	number	600,000	Shingles	number	1,817
Lime	barrels	5,500	Stone, building	cords	138

II 19.

IMPROVEMENT OF THE FOX AND WISCONSIN RIVERS, WISCONSIN.

During the past fiscal year the following work has been done on the Fox River, in accordance with the river and harbor act of August 11, 1888.

The subject of the improvement of the Wisconsin River was referred to the Board of Engineers for fortifications and river and harbor improvements, and the report of the Board was published in House Ex. Doc. No. 65, Forty-ninth Congress, second session.

The Board decided against the application of wing-dams as a means of improvement, and recommended that no more work be done. No work has therefore been done, and no money was appropriated for the improvement of this river in the act of August 11, 1888.

Upper Fox.—The navigation of the river from Portage to Lake Winnebago was maintained, such repairs to dams and locks and such dredging as was necessary to maintain the existing depth being done.

One hundred and forty thousand eight hundred and eighty-two cubic yards of material were dredged from the bars on the Upper Fox, of which 35,899 cubic yards were of very hard clay and gravel. In addition to these amounts deposits of sand were removed from the chambers and recesses of the locks.

Lower Fox.—Extensive repairs were made to the dredging-plant and tug-boats. One dredge was almost entirely rebuilt, only the old boiler, engine, and some of the machinery being retained.

A revetment wall at Little Kaukauna was constructed on the river side of the canal bank, extending from the left abutment to the head of the lock, a distance of 520 feet.

In the construction of the Appleton Lower Dam, a crib-dam 425 feet long with five 20-foot sluice-ways with stone piers and abutments, 350 cubic yards of dry stone wall were laid in the revetment wall and 608 cubic yards of cement masonry laid in the piers and connecting walls, completing the masonry for the sluices.

Extensive repairs were made to the Rapid Croche and the Menasha locks.

Ten thousand eight hundred and eighty-three cubic yards of hardpan, clay, and gravel, and 47 cords of stone were removed from the Menasha River.

It is proposed to widen the Menasha Canal to 100 feet on the bottom and to deepen it to 8 feet below the level of the crest of the Menasha Dam, and one cut was made the entire length about 45 feet wide, removing 31,917 cubic yards of very hard material.

In accordance with the river and harbor act of August 11, 1888, reserving $5,000 for deepening the south outlet of Lake Winnebago, at Neenah, Wis., 11,702 cubic yards of hard material were dredged from the Neenah outlet.

In accordance with a proviso in the same act of Congress a survey of the Fox River between De Pere and Green Bay was made and the proposed channel located. Twenty-four thousand two hundred and fifty-one cubic yards of clay, sawdust, etc., were removed from the channel and dumped between the De Pere Dock and the right shore.

For the details of the work and for the minor repairs to the mechanical structures on the Upper and Lower Fox, attention is respectfully invited to the very full report of Assistant Engineer C. A. Fuller, hereto appended.

The description of the lands needed for the site of the levee to be constructed at Portage, Wis., was forwarded to the Attorney-General for examination, and the United States attorney for the western district of Wisconsin has been directed by the Department of Justice to make the necessary investigation of the titles and to institute condemnation proceedings for acquiring lands where the title is objectionable.

Navigation was continued during the season of 1888 until closed by ice November 20, 1888. It was partially resumed on April 8, 1889, and wholly so on the 30th of the same month.

During the past season, and the present until the recent June rains, the water has been extremely low. On the Upper Fox in May, 1889, the depth of the water on many of the bars was less than 2½ feet.

During the season of navigation the mill-owners have continued, and still continue, to take water from the pools above the Appleton and Menasha dams much in excess of the discharge of the Fox River, thus reducing the levels of Lake Winnebago and Little Lake Butte des Morts below the crests of the dams. This is a constantly growing evil. On the 8th of November, 1886, a suit was filed in equity in the United States court of the eastern district of Wisconsin, against the Winnebago Paper Company and some thirty other mill-owners at Neenah and Menasha, to restrain them from taking water for hydraulic power or other purposes during the season of navigation from the level of Lake Winnebago, above the Government dam at the city of Menasha, when the level of the water in said lake is at or below the crest of said dam. The defendants filed their plea and on March 5, 1887, replication was duly filed. During the spring and summer of 1888 the United States produced witnesses and took testimony from time to time before the master in chancery. The defendants obtained further time in which to put in their proof, and here the matter rests.

Expenditures for the improvement of the Fox River, and for new works, have been made from the appropriations for "Improving Fox River;" the expenditures for repairs, maintaining and operating works, from the indefinite appropriation for "Operating and care of canals and other works of navigation."

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURES DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The balance of the funds available and on hand will be expended in continuing the construction of the lower dam at Appleton, in renovating the Kaukauna second lock and Eureka Lock, in completing the repairs of the Rapid Croche Lock, and the deepening of the Menasha Canal and the river channels to 6 feet at low water.

Of the balance on hand and reported in the accompanying financial statement, not all is available for the improvement of Fox River. Of the amount reported $4,590.71 is a balance remaining from allotments of $10,000 made by the Chief of Engineers by authority of the Secretary of War, under dates of October 24, 1888, and May 10, 1889, to carry out the intention of the provisions of the special act of March 3, 1875, "to aid in the improvement of the Fox and Wisconsin rivers, in the State of Wisconsin," and applicable only to acquiring lands for sites and to pay expenses relating to damages arising from overflowing of lands, etc. These allotments are used principally for the legal expenses incurred in defending the suits for flowage damages against the United States now pending in the State courts.

The river and harbor act of July 5, 1884, appropriated $10,000 for "maintaining the channel between De Pere and Green Bay," which money is being expended for that purpose.

By the river and harbor act of August 11, 1888, $5,000 of the $100,000 appropriated for continuing the improvement, was reserved for deepening the south outlet of Lake Winnebago at Neenah, Wis., and by the same act $6,000 was reserved for building the levee at Portage, Wis., which, with the $6,000 appropriated by the act of August 5, 1886, and made available by the act of August 11, 1888, makes $12,000 in all available for this purpose.

These amounts will be expended in accordance with the requirements of these acts of Congress.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

The estimate herewith submitted is for continuing the work under the project contained in the report of the Board of Engineers, dated September 17, 1884, approved by the Secretary of War December 10, 1884 (see Report of Chief of Engineers, United States Army, for 1885, pages 2041 to 2046, inclusive), as further modified by authority of the Chief of Engineers, upon the recommendation of the Board of Engineers for fortifications and for river and harbor improvements, May 14, 1886, which project as modified contemplated the rebuilding of the Cedars Lock, the renovation of the old locks as they require it, and the deepening and widening the channel of the Fox River throughout to 6 feet depth and 100 feet width, without reference to the original project.

This forms part of the original project, the object of which was to secure a cheap route of transportation from the Mississippi River to the Great Lakes and Atlantic sea-board, the advantages of which are set forth in numerous reports, and especially in the report of Maj. G. K. Warren, Corps of Engineers, in the Report of the Chief of Engineers for 1868, page 357, and in the report of the select committee on transportation routes to the sea-board, United States Senate, 1874.

The present status of this project may be seen from the report of the Board of Engineers contained in House Ex. Doc. No. 65, Forty-ninth Congress, second session.

It is proposed to apply funds given by Congress to first improve the navigation of the river by deepening and widening the channels throughout, by rock excavation and dredging, to the full capacity of the existing locks, in order that the full benefit of the locks already built will be attained and remain available.

This river has its effect upon rates on all freight carried to points in the Fox River Valley, which is the most thickly-settled portion of the interior of Wisconsin and an important manufacturing region; all freights during the season of navigation, and particularly heavy freights, are reduced to near the price of water-carriage, whether carried by boat or by the competing railroads; and for the reason that it is a regulator of freights it is of such value that the works should be maintained and the navigation improved at least to the extent contemplated by the modified project of 1884.

Money statement.

July 1, 1888, amount available		$19,939.61
Fuel sold to officers, deposited to credit of appropriations		190.50
Amount appropriated by act of August 11, 1888		100,000.00
		120,130.11
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$61,869.51	
July 1, 1889, outstanding liabilities	1.25	
		61,870.76
July 1, 1889, balance available		58,259.35
Amount (estimated) required for completion of existing project		446,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

FOX RIVER.

[REPORT OF MR. C. A. FULLER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Appleton, Wis., July 1, 1889.

MAJOR: I have the honor to submit the following report of operations upon the improvement of the Fox River, Wisconsin, from Portage to Green Bay, for the fiscal year ending June 30, 1889:

Work during the year consisted principally in renovating the old Rapid Croche and Menasha locks; in commencing the construction of a new lower dam at Appleton; in building a revetment wall along the canal bank, between the Little Kaukauna Dam and the head of the lock; in completing the excavation by dredging of a 6-foot channel between the foot of Lake Winnebago and the Menasha Canal; in dredging the channel; in making repairs of boats and dredges and incidental repairs of locks, dams, and canal banks.

Navigation throughout the line was continued until closed by ice on the 20th of November, 1888. It was partially resumed on the 8th of April, 1889, and wholly so on the 30th of the same month.

The following outline of operations between Green Bay and Portage under separate heads, viz: "Operating and care of canals and other works of navigation," "Improving Fox River," and "Improving Fox and Wisconsin rivers, Wisconsin," is respectfully submitted.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION.

De Pere Lock and Dam.—A leak at the upper right-wing wall was stopped by driving sheet-piling and filling with clay, and a leak near the right abutment of the dam was stopped by puddling in 30 cubic yards of clay.

Little Kaukauna Lock and Dam—Slight repairs were made to the locks; logs were removed from the sluice-way, and the latter was repaired.

Rapid Croche Lock.—Dredge No. 2 was towed from Menasha and partly put in coffer-dams above and below the lock, putting in 1,000 cubic yards of clay in the lower and 400 cubic yards in the upper one. The dredge was then towed to the third level of the Kaukauna Canal, and the dams were completed by laborers' work.

A centrifugal pump and engine were set up and the water was pumped out and kept out during the progress of the work. Old floor planks were removed and hoisted out of the lock; 320 feet, B. M., of timber were framed and bolted on the mud-sills, and 20 cubic yards of concrete filled in the spaces between the sills. The gates and miter-sills were removed, and new miter-sills framed, placed, and bolted. The joints in the breast wall, upper recess walls, and in rear of the hollow quoins were raked out and repointed with Portland cement. Nine thousand two hundred and forty-seven superficial feet of double planking were placed and spiked on the floors, and 600 superficial feet of old planking removed from the apron, refitted, and replaced. The gates were repaired and rehung; the pump removed and the engine laid up.

On the 30th of April, 1889, Dredge No. 2 made an opening in the coffer-dams for the passage of boats, and on the 10th of May the dredge completed their removal.

There were expended on these repairs, 36,320 feet, B. M., of pine lumber, 4,700 pounds of spikes, 121 barrels of Milwaukee cement, 2 barrels of Portland cement, and 2,186 feet, B. M., of white-oak lumber.

Four solid gates were framed, ironed, and hung.

There were expended on the gates 16,964 feet, B. M., of pine and 4,050 feet, B. M., of white-oak lumber. There were used in the gates 4,669 pounds of bolts, plates, etc., and 3,604 of cast-iron valves.

Kaukauna Fifth Lock.—Stones in the head-walls that had been displaced by passing boats were replaced, and timber coping was framed, placed, and bolted on both walls.

Repairs of waste-weir.—The old weir was taken out and 150 cubic yards of clay excavated; 14,500 feet, B. M., of pine timber were framed and bolted in the cribs, and the cribs filled with 14 cords of stone. The sides and bottom were planked with 5,430 feet of pine and 75 cubic yards of clay were puddled around the walls; 870 pounds of drift-bolts and 300 pounds of nails were expended.

Repairs of the lock-house, Kaukauna Fifth Lock.—Fifty-five cubic yards of masonry were laid in the cellar walls The roof, sides, and floor repaired, and a new chimney was built. The house was painted, and the windows and doors were repaired.

There were expended on this work 10,969 feet, B. M., of pine lumber, 1,000 brick, and 77 bushels of common lime.

Kaukauna Fourth Lock.—One lower gate was taken out; the arms and hangings were repaired, and the gate was replaced. The valve-rods and capstan platforms were repaired.

Kaukauna Third Lock.—Four gate spars were made and placed; the capstan platforms and valve-chains repaired.

Kaukauna Second Lock.—The capstan platforms and valve-rods were repaired, and new spars framed and placed on the gates.

Kaukauna First Lock.—No repairs were required.

Kaukauna Dam.—Three bents and 72 linear feet of foot-bridge were rebuilt in the sluice-way, and logs and drift timber were removed from the sluice.

Kaukauna Canal banks.—Six hundred and twenty-five cubic yards of clay were placed and puddled in the banks of the fourth and fifth levels; 525 cubic yards of clay and 66 cords of rubble-stone were placed along the right bank of the first and second levels to raise and strengthen them. Leaks near the heads of the Fourth and Fifth locks were filled with 150 cubic yards of puddled clay and riprapped with 10 cords of rubble-stone.

Little Chute Combined Locks.—The valve-chains on platforms were repaired.

Little Chute Second Lock.—All four of the capstan platforms were repaired.

Little Chute First Lock.—No repairs were required.

Little Chute Dam.—Now horses and 32 linear feet of stringers were framed and placed in the sluice-way and 32 linear feet of the foot-bridge were replanked.

Cedar Dam.—Slight repairs were made in rear of the left abutment.

Cedar Lock.—The recess valve-gearing was repaired with 75 pounds of new iron castings.

Appleton Fourth Lock.—Twenty-five cubic yards of clay were puddled in near the head of this lock.

Appleton Third Lock.—Slight repairs were made.

Appleton Second Lock.—No repairs were made.

Appleton First Lock.—Twenty-five cubic yards of clay were placed in rear of the head-wall, and puddled, and capstan platform repaired.

Appleton Upper Dam.—No repairs were required.

Menasha Dock.—Coffer-dams were put in above and below the lock, by Dredge No. 3, and laborers' work. A centrifugal pump and an engine were set, the water pumped out and kept so. Large quantities of ice and snow were taken out, from

time to time, 282 cubic yards of mud were excavated from the lock-pit and hoisted out. All of the old posts, girts, planks, etc., were taken out and replaced by new. The old gates were removed, new solid ones framed and ironed, rehung, and the maneuvering gear attached. The old upper miter-sill and platform were taken out; 83 cubic yards of gravel for a supporting wall excavated, and 196 cubic yards of cement masonry laid in the wall. A new miter-sill was framed and bolted in place. Nearly all of the stone in the walls, 2,743 cubic yards, was taken out and relaid. One hundred and fourteen cubic yards of cement masonry were laid in the upper wing-walls; the walls were coped with timber and flat stone. One thousand five hundred and eighty-nine linear feet of mud-sills were put in between the old ones, and the intermediate spaces filled with concrete. Four capstan platforms and the necessary snubbing posts were framed and placed, completing the repairs.

The pump was removed, the engine laid up, tools stored, and the force discharged.

The coffer-dams were taken out by Dredge No. 3.

There were expended on repairs 123,848 feet, B. M., of pine and 37,760 feet, B. M., of oak lumber; 1,589 linear feet of oak mud-sills; 21,552 pounds of iron rods, bolts, plates, castings, etc.; 5,600 pounds of spikes: 400 pounds of nails; 125 barrels of Milwaukee cement and 1 of Portland cement, and 69 cubic yards of sand.

Menasha Dam.—Slight repairs were made to the sluice-gates.

Eureka Lock.—The lower gates were repaired.

Euraka Dam.—Three sluice-gates were repaired by putting in new planks.

Berlin Lock.—Repairs were made to the lower gates, and new spar was framed and placed. Forty-one posts and 200 rods of barbed wire were set and other repairs made to a part of the line fence, to replace that which was carried away by high water.

Berlin Dam.—A break in the dam was repaired with timber sheet-piling, brush-mats, clay, and rubble-stone. One thousand eight hundred and twelve feet, B. M., of pine lumber, 1 keg of nails, and 14 cords of rubble-stone were purchased and placed.

White River Lock.—Two hundred feet of barbed wire, 25 cedar posts, 200 feet, B. M., of fencing boards, and 25 pounds of nails were purchased and expended in making repairs to the line fence on Government property adjacent to this lock.

Princeton Dam.—A break was repaired by putting in 119 brush-mats, 20 cords of rubble-stone, 80 cubic yards of gravel, and 75 of clay.

Grand River Lock.—A portion of the line fence that had been carried away by high water was rebuilt and a small wood-shed built for the lock-tender.

Montello Dam.—New planks were placed and spiked to replace portions of the apron that had been washed away.

Portage Canal Waste-weir.—This weir was rebuilt. Clay was excavated from the sides and ends, all of the old timbers and planks were taken out, 20 posts and 9 cap timbers framed and put in, 2,010 superficial feet of double planking placed in the bottom and sides, and 192 cubic yards of clay backing placed and puddled, completing the repairs.

There were purchased and expended 11,780 feet, B. M., of pine lumber and 4 kegs of wrought spikes.

DREDGING UPPER FOX RIVER.

Dredge No. 4 was put in commission at Berlin Lock on July 1, 1888, was towed to Wilson's Bar, below Grand River Lock, and worked down to the bar above White River Lock, removing from the channel 102,817 cubic yards of material, principally sand; raised the levee between the lock and dam, 480 feet in length, to a height of 9 feet and a width on top of 12 feet. The dredge was then towed to Berlin Lock, the machinery laid up, and the crew discharged November 10.

Dredge No. 6 (pump) was repaired and refitted at Berlin Lock and put in commission on the 28th of August, 1888. The dredge was towed down to Eureka Lock and thence back to Berlin, White River, Princeton, and Grand River locks, removing the deposits of sand from the chambers and recesses of each, and then moved down to Dredge No. 4, and assisted her by throwing over dredge banks. On the 31st of October the boat was laid up at Berlin Lock and the crew discharged.

Dredge No. 5 was put in commission July 17, 1888, and commenced work by removing bog from the upper gate recesses of Berlin Lock and from the canal between the lock and the river above. The dredge then dropped down to Berlin and dredged the channels through the bars down to Grignon Bar, below Omro, removing 35,899 cubic yards of material in very hard digging. At Preacher's Bend and Grignon Bar the material taken out was hard clay and gravel, too compact for the clam-shell dipper of the dredge to work in with satisfactory results. The boat was towed to Oshkosh and laid up for the season on the 23d of November.

On the 1st of June, 1889, the dredge, having been thoroughly repaired, was towed to Princeton Bar, and commenced work for the season on the 4th. Owing to the

very dry season the river had become unusually low, there being but 2 feet of water in the channel through the bar below the lock. A cut was made the entire length of the bar, removing 2,166 cubic yards of sand, making a channel wide and deep enough for boats for the present. The dredge was towed to White River Lock, and made two cuts through the whole length of the bar, removing 12,353 cubic yards of sand.

DREDGING LOWER FOX RIVER.

Cleaning out Menasha Canal.—Dredge No. 3 worked from May 3 to 7, 1889, removing clay and hardpan from the deep cut in the Menasha Canal, taking out 426 cubic yards of material, and was then towed to Neenah River.

REPAIRS OF BOATS AND DREDGES.

Dredge No. 2.—The gallows frame, spuds, spud-guides, bolsters, guard-planks, fenders, cheeks, stringers, and gunwales were framed and placed. A new crane was made and placed, the dipper-arm re-dressed and racks put on, the deck was re-planked and calked, and the cabin repaired. All new work was painted. The repairs of the machinery were completed and the boat towed to Rapid Croche Lock on the 28th of April.

There were purchased and expended on these repairs 563 feet, B. M., of pine lumber, 400 pounds of round iron, 300 pounds of boat spikes, 52 pounds of Babbit-metal, 1 bale of oakum, 100 pounds of white lead, 100 pounds of mineral paint, and 10 gallons of boiled oil.

Dredge No. 3.—The boat was blocked up in Little Chute Combined locks, a hole in the bottom planked and calked, the boat floated, and the crane repaired. After dredging a bar that formed in the river outlet of the locks, the dredge was towed back to Menasha.

Three thousand feet, B. M., of pine lumber were purchased and expended on these repairs.

Tug-boat Dekorra.—The cylinder was re-bored, new cylinder rings were made and fitted, new water-wheel flanges cast, new wheel arms put in, the old nosing of main deck and portions of the plank shear removed and replaced by new, a new smoke-stack was set up, and the hull and cabin were repainted.

There were purchased and expended 484 feet, B. M., of oak and 340 of pine lumber, 517 pounds of iron castings, 25 pounds of iron stirrups, 100 pounds of white lead, 50 pounds of mineral paint, 27 gallons of boiled oil, and 2 pounds of lamp-black.

Steam-launch General Meade.—The machinery was cleaned and slightly repaired, a new propeller wheel purchased and put in, a supply-pump for the boiler attached, and the boat repainted.

Twenty-five pounds of white lead, 3 gallons of boiled oil, and 1 pound of lamp-black were purchased and expended.

Dredge No. 5.—The necessary repairs for putting the dredge in commission were made. The boiler was patched, pinions re-bushed, new cylinder springs put in, clam-shells riveted, boom and shovel set up, and all of the machinery put in working order. The repairs were completed on the 17th of July, 1888, and the dredge put in commission.

November 21 she was towed to Oshkosh for further repairs. The sides of the hull were repaired and calked, and two grousers made. Turn-buckles were put in the A frame back stays and the iron work of the frame was repaired. The boom was taken out and a new one put in. Blocking was placed under the boiler and the boiler patched. Bed timbers were put in under the hoisting engine and the clam shell and frame were repaired.

There were purchased and expended 5,895 feet, B. M., of oak and pine lumber, 291 pounds of steel, and 384 pounds of iron.

Dredge No. 6 (*pump*).—All steam and pump joints were made over and the boiler was placed and bolted. The pumps were placed and the inspirator and suction pipes put in. The boom was set up and derrick repaired. Chains were attached to the pontons and the wood scow and skiff repaired. The repairs were completed on the 28th of August, 1888, and the dredge put in commission.

Tug-boat Boscobel.—Seventy superficial feet of deck were laid, a new gallows frame put in, and the bridge truss repaired. Hog-chains for the wheels were made and put in, and the timbers for the engine bed and wheel shafts made and bolted. The cabin was extended forward by adding two rooms, and the pilot-house moved forward. Two water-wheels were made and put in, a tow post and kevels made, and the deck was calked. Tie-rods between the keelson and deck were put in. The boiler and engine were repaied on shore, placed on board, and the machinery cleaned and set up. The cabin was painted and the repairs were completed on the 25th of May, 1889.

Two thousand four hundred and ten feet, B. M., of pine lumber, 213 pounds of boat spikes, 450 pounds of iron hog-chains, rods, etc., 500 fire-bricks, and 10 bales of oakum were purchased and expended.

IMPROVING FOX RIVER.

Construction of Little Kaukauna revetment wall.—A wall on the river side of the canal bank, extending from the left abutment of the dam a distance of 520 feet to the head of the lock, was built. Seven hundred and forty cubic yards of gravel were excavated from the site of the wall; fourteen cribs 10 feet by 20 feet by 3 feet 4 inches, and two cribs 10 feet by 20 feet by 4 feet 4 inches were framed, bolted, placed, and filled with stone; 394 cubic yards of dry stone wall were laid on the cribs and 83 cubic yards of gravel were placed in rear of the walls, completing the work.

Sixty-three cords of rubble-stone were brought from Menasha and Cedars; 5,271 feet, B. M., of pine lumber and 5,040 pounds of drift bolts were purchased and expended.

Construction of Appleton Lower Dam.—Measurements and soundings were made and plans prepared for a new crib-dam, with five 20-foot sluice-ways and stone piers and abutments, the sluice-ways to be provided with "Taintor" gates. Dressed stone was selected at the Kaukauna quarry grounds for the piers and abutments. A tool house was built, tools repaired, and 50 linear feet of coffer-dam put in; 250 cubic yards of rock and clay were excavated for the site of a retaining-wall along the left bank of the canal. A crib for the derrick guy was built and sunk in the river and a derrick made and set up; the pump and engine were set and the water pumped out. One hundred and twenty cubic yards of rock and gravel were excavated from the site of the right abutment and of No. 1 Pier; 350 cubic yards of dry stone were laid in the revetment wall; 207 cubic yards of cement masonry were laid in the right abutment and 65 in No. 1 Pier; 120 cubic yards of clay were filled in in rear of the revetment wall and 280 in rear of the abutment; 729 superficial feet of stones were dressed for quoins, gate seats, etc., and 521 superficial feet for coping. The gate seats were secured to solid rock by seven iron dowels 18 inches long and 1¼ inches round, for No. 1 Pier.

The revetment wall, one pier, and the right abutment were completed on November 30, 1888, the work suspended for the season, and the force discharged and the plant stored.

Work was resumed April 26, 1889. Coffer-dams were put in and the water pumped out. Two derricks were set up and a track for stone cars put down. Gravel and shell rock were excavated from the sites of the piers and gate walls, and the bed-rock was leveled off. Three hundred and thirty-six cubic yards of cement masonry were laid in the piers and connecting walls, completing the masonry for sluices.

Three hundred and ninety-five cubic yards of clay were boated and placed in the coffer-dams. Stone was dressed for coping, gate steps and circles, pier steps, corners, and closing stones.

Stone for the walls was hauled from Kaukauna quarry grounds to the canal, boated to the vicinity of the dam, and unloaded on the canal bank. The framing of sluice-gates was completed ready for planking. A coffer-dam was put in for left abutment.

There were purchased and partly expended on construction 169,769 feet, B. M., of pine lumber, 12,304 of oak, and 40,000 of hemlock; 14,630 pounds of drift-bolts; 2,800 pounds of wrought spikes; 1,900 pounds of nails; 1,038 pounds of gate anchor bolts; 512 barrels of Milwaukee cement and 8 barrels of Portland cement, for pointing; 52 cubic yards of sand.

Construction of side dump-scows.—Two dump-scows, each 78 feet 6 inches long, 18 feet 6 inches wide, with eight pockets, were built. Total capacity of each, 77.69 cubic yards.

There were purchased and expended in their construction 51,250 feet, B. M., of oak and pine lumber 2,000 deck plugs, 4,131 pounds of spikes, 1,000 pounds of nails, 8,450 pounds of bolts and washers, 5,947 pounds of hinges and fender irons, 354 pounds of fish plates, 7,204 pounds of iron, 2,918 pounds of chains, 12 bales of oakum, and 2 barrels of pitch, 12 tamarack knees.

DREDGING LOWER FOX.

Deepening Menasha River.—Dredge No. 2 completed the dredging between the foot of the rock cut and the head of the Menasha Canal, removing 10,883 cubic yards of hard pan, clay, and gravel, and 47 cords of stone, which was placed on flat scows, poled to the right bank of the river, wheeled on shore, and piled. This work was completed on the 6th of September, when the dredge moved to the canal.

Deepening Menasha Canal.—It is proposed to widen the canal to 100 feet on the bottom and to deepen it to 8 feet below the level of the crest of the Menasha Dam. One

cut to the required depth, the entire length of the canal and about 45 feet in width, was made by Dredges Nos. 2 and 3, removing in all 31,917 cubic yards of clay, gravel, and hard pan, of which 3,673 cubic yards were placed on flat scows, towed to the right bank near the lock, wheeled on shore; 2,788 cubic yards were thrown by the dredge on the right bank; 7,195 cubic yards were placed on flat scows, poled through the lock to Little Lake Buttes-des Morts, and shoveled off; 3,952 were put in dump-scows, towed to the canal basin on left, and dumped, and 14,309 towed to the lake and dumped.

The work was suspended November 20, 1888, no more funds being available. The dredged channel is of sufficient width for boats navigating the canal to pass through.

Deepening south outlet of Lake Winnebago, Neenah, Wis.—A survey of the proposed channel was made, buoys were set, and three guiding-cribs framed, sunk in place, and filled with stone. Dredge No. 3 was towed to the river on the 8th of May, 1889, and began dredging. Eleven thousand seven hundred and two cubic yards of hard pan, clay, and gravel have been taken out, placed on scows, and dumped. Six thousand and fifty-eight feet, B. M., of pine lumber were bought and expended in building cribs.

REPAIRS OF BOATS AND DREDGES.

On the close of navigation Dredge No. 2 was blocked up in the third level of the Kaukauna Canal for repairs, which were begun on the 11th of February, 1889. The turn-table, old knees, girts, hog-chains, and posts, rudder-post, and fan-tail timbers were taken out and replaced by new. The hoisting and backing drums were removed, repaired, and replaced. The swinging engine and bed were taken out, a new bed put in, and the engine taken apart, cleaned, and set up. Twelve tamarack knees were dressed, placed and bolted, and the hull was calked.

Seven thousand ninehundred and sixty-two feet, B. M., of oak lumber, 5,556 of pine, 23 knees, 1,199 pounds of round iron, 830 pounds of iron castings, 63 pounds of steel, 4 bales of oakum, and 1 barrel of pitch were purchased and expended.

Tug-boat Dekorra.—A new bulkhead was put in, coal bunker built, new grouser framed, and fender-straps put on the stern. The boiler-deck, pilot-house, and inside of the cabin were painted one coat; 744 feet, B. M., of pine lumber were purchased and expended.

DREDGING UPPER FOX—REPAIRS OF BOATS AND DREDGES.

Tug-boat Boscobel.—The old paddle-wheels, the boiler and engine, and most of the machinery were taken out; 400 superficial feet of old decking, 132 linear feet of plank shear, and 363 linear feet of wales were removed and replaced by new; 41 deck and 1 wheel beam were spliced, 4 chocks were framed and placed, and hatch-combing were framed, put on, and bolted; 1,500 feet, B. M., of oak lumber, 215 pounds of spikes, and 100 pounds of nails were purchased and expended.

Dredge No. 7.—The engine, boiler, and most of the machinery were removed from the old hull at Berlin, placed on a barge, and towed to Oshkosh. A new hull was constructed, launched, and a new cabin built. The old boiler, hoisting-engine, and some of the machinery were repaired, cleaned, and replaced. The following new machinery was purchased, received, and nearly all placed: One iron turn-table, iron work for boom, dipper-handle friction, iron-work for A frame, boom stay rods, spud fixtures, chocks, slips, sheaves, etc., swinging engine, clam-shell bucket, 3 cubic yards capacity; scoop-dipper, 46 cubic feet, with four steel teeth. There were also purchased and received 10,725 pounds of chain, 4,747 pounds of screw-bolts and washers, 1,300 pounds of spikes, 400 pounds of nails, 5,563 pounds of round iron, 4,731 pounds of iron rods, bolts, etc., 4,815 pounds of stay-rods, 1,601 pounds of fender iron, 1,280 pounds of iron castings, 109,190 feet, B. M., of oak and pine lumber, 34 tamarack knees, 4,000 deck-plugs, 700 pounds of white lead, 100 pounds of black paint, 1 barrel of boiled oil, 20 bales of oakum, and 2 barrels of pitch.

The repairs are nearly completed.

IMPROVING FOX AND WISCONSIN RIVERS—DREDGING FOX RIVER BETWEEN DEPERE AND GREEN BAY, WISCONSIN.

A survey of the river was made and the proposed channel located. Three water-ganges were set, one at Green Bay and two at intermediate points, and two of them, with the gauge at the lock, were read three times daily. A base-line 1,900 feet in length was measured, and 20 triangulation posts were set on both sides of the river; 154 triangulation angles, 322 stadia readings, 1,451 sounding-angles were taken, and 6,558 soundings made. In addition, 255 channel soundings were made between the railroad bridge and the elevator in the harbor at Fort Howard; the least depth found was 17 and the greatest 42 feet.

Dredge No. 2, with dump-scows, was towed from Rapid Croche Dock to Depere and commenced dredging on the bar opposite the Furnace Dock, making a channel 200 feet wide and 12 feet deep below the level of extreme low water. Twenty-four thousand two hundred and fifty-one cubic yards of clay, sawdust, etc., were removed, placed on scows, and dumped between the dock and the right shore.

There were purchased and received for the use of the dredge, 2 new steel pinions, 101 pounds of manila rope, and 1 barrel of lard oil for machinery.

MISCELLANEOUS.

The tug-boat *Boscobel* was employed in towing dredges on the Upper Fox, from place to place, in supplying them with fuel, in towing scows with materials for repairs of dams, and on inspection trips.

The tug-boat *Dekorra* towed dump-scows for Dredges Nos. 2 and 3 on the Lower Fox, and made inspection trips.

The steam-launch *General Meade* was employed in towing scow-loads of materials, tools, etc., for works in progress on the Lower Fox and in making trips for inspection and payment.

The steamer *Henrietta* was laid up at Appleton, Wis., on the 20th of November, 1886, and has not since been put in commission.

The following work is required to be done to complete this improvement, viz: To complete the construction of the lower dam at Appleton; to renovate the Kaukauna second lock, and the locks at Eureka, Fort Winnebago, and Portage City; to complete the repairs of Rapid Croche Lock; to finish the deepening of the Menasha Canal; to deepen the river channels to 6 feet at low water and to build dwellings for lock-tenders.

Very respectfully, your obedient servant,

C. A. FULLER,
Assistant Engineer.

Maj. CHAS. E. L. B. DAVIS,
Corps of Engineers, U. S. A.

Commercial statistics for the calendar year 1888.

The nearest collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee, Wis.; amount of revenue collected during year, $291,492.63.

Articles transported on Fox River, Wisconsin.

Articles.	Quantity.	Articles.	Quantity.
Logs, lumber, lath, and shingles, feet, B. M.	122,900,000	Brick ..... number..	778,500
Stone (lime, rubble, and dimension) ..... cords..	5,563	Salt ..... barrels..	16,000
Sand, gravel, and clay .. cubic yards..	9,697	Lime ..... do....	75,000
Wood, cord ..... cords..	12,369	Flour ..... do....	100
Wood, pulp ..... do....	3,400	Varnish and oil ..... do....	400
Timber, kit ..... do....	1,800	Eggs (in barrels) ..... do....	450
Stave-bolts ..... do....	80	Eggs (in cases) ..... cases..	1,800
Sewer pipe ..... tons..	750	Butter (in tubs) ..... tubs..	4,000
Coal, hard and soft ..... do....	13,344	Cheese (in boxes) ..... boxes..	2,500
Iron ore ..... do....	280	Cheese-boxes (empty) ..... do....	6,000
Pig-iron ..... do....	2,000	Buggies ..... number..	155
General merchandise and sundry freight ..... tons..	3,345	Wagons ..... do....	20
		Passengers ..... do....	27,500

List of boats navigating Fox River from Portage to Green Bay, Wisconsin.

Name of boat.	Draught.	Tonnage.	Steam or sail.	Name of boat.	Draught.	Tonnage.	Steam or sail.
	Feet.				*Feet.*		
K. M. Hutchinson	4½	138.08	Steam.	Rover	4	67.00	Sail.
Fashion	3½	70.00	Do.	Georgie	5½	82.00	Do.
B. F. Carter	5	125.00	Do.	Morning Bell (tug)	5	9.00	Steam.
Ossian Cook	5	175.00	Do.	Morning Bell	3½	70.00	Barge.
S. B. Baige	5	75.00	Sail.	C. S. Morris	3	90.00	Steam.
Rosebud	5	75.00	Do.	City of Berlin	3	100.00	Do.
Evalyn	5½	150.66	Steam.	J. M. Marston	5	100.00	Do.
Austin	(*)	(*)	Sail.	M. D. Moore (tug)	3	(*)	Do.
E. B. Maxwell	(*)	(*)	Do.	D. L. Libbey (tug)	3	(*)	Do.
Traverse City	(*)	(*)	Steam.	Huntress (tug)	3	(*)	Do.
Northerner	(*)	(*)	Do.	W. W. Neff (tug)	3	(*)	Do.
Eleanor	(*)	(*)	Sail.	Union (tug)	3	(*)	Do.
Ellen Hardy	(*)	(*)	Steam.	H. Collette (tug)	5	(*)	Do.
City of Nicholett	6	124.00	Do.				

* Unknown.

II 20.

OPERATING AND CARE OF LOCKS AND DAMS ON THE FOX RIVER, WISCONSIN.

The expenditures for maintaining the existing depth of navigation throughout the Fox River and canals; for repairs to mechanical constructions that have been completed and in use, but afterwards injured by flood or otherwise; for current repairs to old locks and dams, and for lock-tenders' services, have been paid from the indefinite appropriation for "operating and care of canals and other works of navigation," provided by section 4 of the river and harbor act of July 5, 1884.

In accordance with this section an itemized statement of the expenditures is appended herewith.

Under this same indefinite appropriation for "operating and care of canals and other works of navigation," it is proposed to do the following work during the fiscal year ending June 30, 1890:

To reline with timber the old Kaukauna Second Lock; to construct new gates at Fort Winnebago, Eureka, Appleton Second, and Kaukauna second locks; to build new floors and make repairs at Eureka, Rapid Croche, and other stone locks; to drive guide-piles at the entrances of seven locks on the Upper Fox; to rebuild the revetment-wall of the Kaukauna Canal for a length of 1,250 feet. During the season of navigation it is also proposed to dredge bars and obstructions which may have filled in, and to maintain navigation through the locks, and to operate and care for the works.

Money statement.

July 1, 1889, amount expended during fiscal year	$48,329.62
July 1, 1889, outstanding liabilities	616.56
	48,946.18
Amount (estimated) for expenditures in fiscal year ending June 30, 1890	62,760.00

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION APPLIED TO FOX AND WISCONSIN RIVERS, WISCONSIN; SECTION 4 OF RIVER AND HARBOR ACT OF JULY 5, 1884.

Detailed statement of expenditures for fiscal year ending June 30, 1889, with itemized statement of expenses attached, as required by the above act of July 5, 1884.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of De Pere Lock	Labor		$3.10
Repairs of canal banks at De Pere	Labor and transportation		23.82
Repairs of Little Kaukauna Lock	Labor	$6.00	
Do	Lumber	2.56	
			8.56
Repairs of Little Kaukauna Dam	Labor		12.00
Repairs of Rapid Croche Lock	do	2,188.13	
Do	Materials	1,531.38	
			3,719.51
Repairs of waste-weir, Kaukauna Fifth Lock	Labor	307.42	
Do	Materials	339.89	
			647.31
Repairs of Kaukauna Fifth Lock	Labor		63.60
Repairs of lock-house, Kaukauna Fifth Lock	do	194.12	
Do	Materials	382.75	
			576.87

Detailed statement of expenditures for fiscal year ending June 30, 1889, etc.—Continued.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of Kaukauna Fourth Lock	Labor	$19.50	
Do	Materials	1.30	
			$20.80
Repairs of Kaukauna Third Lock	Labor		52.00
Repairs of Kaukauna Second Lock	do		44.50
Repairs of Kaukauna Dam	do		71.25
Repairs of Kaukauna Canal banks	Labor and transportation		668.44
Repairs of Little Chute Second Lock	Labor		42.50
Repairs of Little Chute Dam and canal	do		180.75
Repairs of Appleton Canal banks	do		14.22
Repairs of Appleton Third Lock	do		77.50
Repairs of Appleton First Lock	Materials	8.00	
Do	Labor	5.00	
			13.00
Repairs of Cedars Lock	Materials		13.84
Repairs of Menasha Lock	Labor and transportation	8,003.29	
Do	Materials	4,771.63	
			12,774.92
Repairs of Menasha Dam	Materials		8.34
Repairs of Menasha Canal	Labor		59.16
Dredging bars, Lower Fox	do	2,368.20	
Do	Fuel, supplies, etc	1,095.74	
			3,463.94
Dredging bars, Upper Fox	Labor	6,510.50	
Do	Fuel, supplies, etc	4,650.41	
			11,161.00
Repairs of lock-house at Eureka	Labor		9.88
Repairs of Berlin Dam	do	83.06	
Do	Materials	74.78	
			162.84
Repairs of Berlin Lock	Materials		16.41
Repairs of White River Lock	do		17.92
Repairs of lock-house at Princeton	Wall paper, etc		10.65
Repairs of Princeton Dam	Labor	372.41	
Do	Materials	130.30	
			502.71
Repairs of lock-house at Grand River	Lumber, nails, etc		13.65
Repairs of Montello Dam	Lumber		10.44
Repairs of Fort Winnebago Lock	Materials		2.16
Repairs of waste-weir, Portage Canal	Labor	189.49	
Do	Materials	190.73	
			380.22
General repairs of locks and dams	Labor and transportation	1,119.95	
Do	Materials	1,942.80	
			3,062.75
Maintenance of navigation	Lumber for guiding cribs	89.10	
Do	Lock-tenders' services	4,999.46	
Do	Gauge keepers' services	180.00	
Do	Labor and transportation	13.17	
			5,231.73
Care of works and property	Watchmen, labor, and transportation.	1,106.98	
Do	Traveling expenses of assistant engineers and overseers.	189.06	
Do	Hire of house at Appleton	45.00	
			1,341.04
Contingencies	Salaries of assistant engineers, clerks, etc.	3,230.00	
Do	Rent of office at Appleton	100.00	
Do	Rent of telephone	16.15	
Do	Rent of office at Milwaukee	140.00	
Do	Mileage of officers	47.04	
Do	Stationary	280.00	
			3,813.19
Total			48,328.04

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Fox River Wisconsin.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1888.				
July 11	1	Erskin E. Bailey	Services	$14.02
11	2	A. L. Smith	Hire of house	45.00
31	3	Cramer, Aikens & Cramer	Rent of office	70.00
31	4	C. A. Fuller	Services	200.00
31	5	James Clear	....do	35.00
31	6	William Edwards	....do	35.00
31	7	John Lewis	....do	30.00
31	8	John M. Paige	....do	35.00
31	9	John Baeten	....do	30.00
31	10	Andrew O'Connell	....do	10.00
31	11	Alexander Sims	....do	30.00
31	12	A. Sanford Manufacturing Company	Pike poles, etc	10.90
31	13	Battis Bros	Screw bolts, etc	48.81
31	14	McKenzie & Crawford	Coal	71.95
31	15	J. R. Brown	Oil	5.75
31	16	Niels Johnson	Steel, etc	35.83
31	17	C. A. Peck	Packing, etc	11.90
31	18	H. Stedman	Coal	116.85
31	19	H. S. Sacket	Oil, etc	16.92
31	20	Des Forges & Co	Stationery	14.15
31	21	Joys, Norris & Co	Waste	9.82
31	22	H. Bosworth & Sons	Oil	41.00
31	23	Shadbolt & Boyd Iron Company	Barbed wire, etc	29.08
31	24	Schlafer, Barrett & Tesch	Packing, etc	10.08
31	25	Priest & Garrow	Wood, etc	238.00
31	26	C. A. Fuller	Traveling expenses	9.94
31	27	Ramsay & Jones	Lumber	84.78
31	28	Richard E. Rice	Services	16.00
31	29	Hired men	....do	2,100.47
Aug. 7	1	Fred. Lappins	....do	5.10
7	2	Sam Van Camp	....do	5.10
9	3	Erskine E. Bailey	....do	3.00
15	4	Joseph Urban	....do	4.25
29	5	Joys, Norris & Co	Rope	113.73
29	6	H. Bosworth & Sons	Oil	36.38
29	7	Hoffmann & Billings Manufacturing Company, limited.	Hose, etc	48.33
29	8	Matthews Bros. Furniture Company	Mattresses, etc	80.26
29	9	Theodore Demro	Clay	12.00
29	10	W. F. Montgomery	White lead, etc	18.10
29	11	C. S. Buckland	Oil cloth, etc	11.25
29	12	Gerry Lumber Company	Lumber	89.64
29	13	Ramsay & Jones	....do	12.16
29	14	J. H. Marston & Co	Wood	24.00
29	15	F. H. Blood	Coal	14.65
29	16	H. A. Foster	Oil, etc	2.95
29	17	Alfred Galpin's Sons	Screens, etc	26.77
29	18	Appleton Machine Company	Iron, etc	8.37
29	19	S. S. Little	Steel, etc	2.00
29	20	J. J. Marshall	Oil, etc	2.12
29	21	Howard & Jennings	Iron castings, etc	3.88
29	22	J. C. Koelsch	Oil, etc	4.83
29	23	McKenzie & Crawford	Coal	41.68
29	24	E. P. Bangs	Wood	368.65
29	25	H. Stedman	Coal, etc	108.37
29	26	C. A. Peck	Rope, etc	14.58
29	27	Niels Johnson	Steel, etc	72.43
29	28	H. S. Sacket	Packing, etc	3.75
29	29	Priest & Garrow	Wood	184.50
31	30	C. A. Fuller	Services	200.00
31	31	James Clear	....do	35.00
31	32	William Edwards	....do	35.00
31	33	Richard E. Rice	....do	16.00
31	34	John Lewis	....do	30.00
31	35	Jerry Parkinson	....do	30.00
31	36	Gottlieb Jahnke	....do	30.00
31	37	Alexander Sims	....do	30.00
31	38	John M. Paige	....do	35.00
31	39	John Baeten	....do	30.00
31	40	Andrew O'Connell	....do	10.00
31	41	C. A. Fuller	Traveling expenses	11.46
31	42	Hired men	Services	3,235.56
Sept. 15	1	Edward Garring	....do	5.25
30	1	Cramer, Aikens & Cramer	Rent of office	70.00
30	2	C. A. Fuller	Services	200.00
30	3	James Clear	....do	35.00
30	4	William Edwards	....do	35.00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1888.				
Sept. 30	5	Richard E. Rice	Services	$16.00
30	6	John Lewis	....do	30.00
30	7	Jerry Parkinson	....do	30.00
30	8	John Baeten	....do	30.00
30	9	Alexander Sims	....do	30.00
30	10	John M. Paige	....do	35.00
30	11	Andrew O'Connell	....do	10.00
30	12	B. T. Gilmore	Rent of office	25.00
30	13	H. Stedman	Coal	201.30
30	14	C. A. Peck	Packing, etc	31.54
30	15	Niels Johnson	Valve lever, etc	6.55
30	16	H. S. Sacket	Files, etc	2.00
30	17	Reese & Whiting	Soap, etc	6.80
30	18	Priest & Garrow	Wood	336.00
30	19	Des Forges & Co	Stationery	40.20
30	20	C. A. Fuller	Traveling expenses	7.62
30	21	Matthews Bros. Furniture Company	Mattresses, etc	46.44
30	22	Joys, Norris & Co	Rope	28.86
30	23	H. Bosworth & Sons	Oil	91.62
Oct. 4	1	Hired men	Services, September, 1888	1,771.40
9	2	Maj. Charles E. L. B. Davis	Mileage	16.00
31	3	C. A. Fuller	Services	200.00
31	4	Andrew O'Connell	....do	10.00
31	5	James Clear	....do	35.00
31	6	William Edwards	....do	35.00
31	7	John Baeten	....do	30.00
31	8	John Lewis	....do	30.00
31	9	John M. Paige	....do	35.00
31	10	Gottlieb Jahnke	....do	30.00
31	11	Alexander Sims	....do	30.00
31	12	Richard E. Rice	....do	16.00
31	13	Jerry Parkinson	....do	30.00
31	14	C. A. Fuller	Traveling expenses	8.82
31	15	O. L. Packard	Forge	29.40
31	16	E. G. Fox	Wood	65.00
31	17	Priest & Gorrow	....do	318.12
31	18	August Swanke	....do	90.00
31	19	Des Forges & Co	Stationery	32.45
Nov. 1	1	Niels Johnson	Steel, etc	19.60
1	2	R. Mueller	Wall paper, etc	9.65
5	3	Hired men	Services, October, 1888	2,151.72
7	4	Charles M. Cole	Traveling expenses	14.43
13	5	Maj. Charles E. L. B. Davis	Mileage	16.96
17	6	Hired men	Services	137.70
22	7	James Clear	....do	23.33
22	8	William Edwards	....do	23.33
23	9	Richard E. Rice	....do	18.66
23	10	John Lewis	....do	20.00
23	11	Jerry Parkinson	....do	20.00
24	12	C. A. Fuller	Traveling expenses	12.80
24	13	Gabriel Wick	Services	20.00
26	14	Hired men	....do	396.33
30	15	....do	....do	415.60
30	16	C. A. Fuller	....do	200.00
30	17	Andrew O'Connell	....do	10.00
30	18	John A. Banker	....do	30.00
30	19	Gottlieb Jahnke	....do	20.00
30	20	George Gifford	....do	20.00
30	21	Alexander Sims	....do	20.00
30	22	John M. Paige	....do	21.66
30	23	Kaukauna Lumber and Manufacturing Company.	Lumber, etc	285.19
30	24	J. H. Marston & Co	Bricks	7.00
30	25	N. A. Chapelle & Son	Wall paper, etc	9.88
30	26	H. Stedman	Coal	74.23
30	27	C. A. Peck	Iron, etc	12.63
30	28	Niels Johnson	....do	1.65
30	29	Priest & Gorrow	Wood	21.37
30	30	J. J. McDonald	Lumber, etc	22.44
30	31	J. E. Wells & Co	Spikes, etc	20.89
30	32	A. J. Weir	Lumber	169.84
30	33	C. A. Fuller	Traveling expenses	13.25
Dec. 5	1	Hired men	Services, November, 1888	1,338.68
5	2	Ferdinand J. Finder	Plastering	64.00
6	3	Charles M. Cole	Traveling expenses	7.76
8	4	H. Collette	Lumber	2.56
10	5	E. J. Kitsmiller	Painting	24.00
14	6	Frank Rodgers	Services	3.00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1888.				
Dec. 21	7	Hired men	Services	$153.16
31	8	H. Collette	Lumber	24.00
31	9	Butler Brothers	Rubber packing, etc	7.57
31	10	Feller & O'Connell	Spikes, etc	64.51
31	11	J. C. Koelsch	Iron, etc	13.12
31	12	A. Sanford Manufacturing Company	Cant-hooks	9.00
31	13	J. H. Langenberg	Rubber boots	15.00
31	14	B T. Gilmore	Rent of office	25.00
31	15	Schlafer, Barrett & Teach	Spikes, etc	129.33
31	16	Appleton Machine Company	Drift bolts	21.13
31	17	Ramsay & Jones	Lumber	448.06
31	18	C. A. Fuller	Services	200.00
31	19	do	Traveling expenses	4.63
31	20	William Edwards	Services	40.00
31	21	John A. Banker	do	30.00
31	22	John M. Paige	do	25.00
31	23	James McDaniel	Wood	86.62
31	24	McGregor Brothers	Lumber	74.19
31	25	Milwaukee Cement Company	Cement	97.70
31	26	DesForges & Co	Stationery	61.00
1889.				
Jan. 4	1	Hired men	Services, December, 1888	2,027.42
9	2	Andrew Getrild	Services	18.00
14	3	A. A. Burbank	do	1.50
14	4	Hired men	do	76.56
23	5	Frank Wright	do	6.00
24	6	Hired men	do	469.70
31	7	C. A. Fuller	do	200.00
31	8	John Kilawee	do	25.00
31	9	William Edwards	do	30.00
31	10	John A. Banker	do	30.00
31	11	John M. Paige	do	25.00
31	12	Alexander Sims	do	19.16
31	13	Hatch & Keith	Timber	1,456.27
31	14	Milwaukee Cement Company	Cement	103.26
31	15	C. A. Berthelet	do	8.08
31	16	Simons & Tuttle	Steel collar, etc	1.30
31	17	Feller & O'Connell	Spikes	103.52
31	18	Ramsay & Jones	Lumber	1,814.07
31	19	J. C. Koelsch	Oil, etc	16.22
31	20	J. J. Marshall	do	1.15
31	21	Webster Manufacturing Company	Iron bolts, etc	11.10
31	22	McGregor Brothers	Lumber	16.94
31	23	Howard & Jennings	Iron, etc	4.77
31	24	M. A. Wheeler	Sand, etc	33.20
31	25	McKenzie & Crawford	Coal	10.00
31	26	P. E. Smith	Lumber	109.33
31	27	Charles M. Cole	Traveling expenses	4.81
Feb. 4	1	Hired men	Services, January, 1889	1,556.64
7	2	John Flynn	Services	13.00
26	3	Ramsay & Jones	Oak timber	196.47
26	4	Appleton Machine Company	Iron rods, etc	354.24
26	5	J. C. Koelsch	Pick handles, etc	5.61
26	6	Howard & Jennings	Iron bolts, etc	4.39
26	7	John Schneider	Window sash, etc	1.40
26	8	Milwaukee Cement Company	Cement	105.80
28	9	C. A. Fuller	Services	200.00
28	10	William Edwards	do	30.00
28	11	John A. Banker	do	30.00
28	12	John Kilawee	do	25.00
28	13	John M. Paige	do	25.00
28	14	Alexander Sims	do	25.00
Mar. 4	1	Hired men	Services, February, 1889	1,553.62
9	2	do	Services	13.57
31	3	C. A. Fuller	do	200.00
31	4	William Edwards	do	30.00
31	5	John A. Banker	do	30.00
31	6	Alexander Sims	do	25.00
31	7	John M. Paige	do	25.00
31	8	Appleton Machine Company	Iron castings, etc	490.24
31	9	Alfred Galpin's Sons	Spikes	52.80
31	10	B. T. Gilmore	Rent of office	25.00
31	11	Howard & Jennings	Bolts and nuts	10.11
31	12	J. C. Koelsch	Oil, etc	7.54
31	13	C. Bachelder	Coal	1.68
Apr. 1	1	Hired men	Services, March, 1889	1,850.48
2	2	C. A. Fuller	Traveling expenses	8.85
10	3	Samuel Whitney	do	15.72

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1889.				
Apr. 30	4	C. A. Fuller	Services	$200.00
30	5	Andrew O'Connell	do	5.33
30	6	John A. Banker	do	30.00
30	7	John M. Paige	do	30.00
30	8	James Clear	do	22.00
30	9	Alexander Sims	do	27.50
30	10	George Gifford	do	23.00
30	11	William Edwards	Services	23.83
30	12	Richard E. Rice	do	23.00
30	13	Jerry Parkinson	do	23.00
30	14	Gottlieb Jahnke	do	23.00
30	15	Gabriel Wick	do	23.00
30	16	John Lewis	do	23.00
30	17	H. J. Campbell	do	5.00
30	18	H. I. Wheeler	Wrench, etc	2.10
30	19	Butler Bros	Babbitt metal, etc	58.45
30	20	Solar & Co	Coal	1.22
30	21	Simons & Tuttle	Steel bushing, etc	68.67
30	22	Appleton Machine Company	Iron, etc	96.30
30	23	John Schlosser	Smoke-stack	12.45
30	24	C. Bacheldor	Coal	1.56
30	25	Howard & Jennings	Screw-bolts, etc	19.26
30	26	J. C. Koelsch	Packing, etc	14.72
30	27	J. C. Koelsch	Rope, etc	6.40
30	28	W. P. Rounds	Hay	2.00
30	29	W. E. Wheeler	Sand	17.00
30	30	Webster Manufacturing Company	Nuts, bolts, etc	8.34
30	31	Des Forges & Co	Stationery	20.00
30	32	R. Davis	Iron	3.00
30	33	C. A. Fuller	Traveling expenses	9.93
30	34	D. T. H. MacKinnon	Nuts	1.33
30	35	McGregor Bros	Lumber	31.54
30	36	McKenzie & Crawford	do	5.47
30	37	Jas. Gillingham & Son	Hog-chains, etc	53.86
30	38	K. M. Hutchinson	Boat-spikes, etc	10.29
30	39	Paine Lumber Company	Lumber	49.30
30	40	Warnke & Zauft	Barbed wire, etc	17.92
May 4	1	Hired Men	Services, April, 1889	3105.93
8	2	Atlas Iron and Brass Works	Iron castings	12.80
10	3	Hans Jacobson	Services	15.12
10	4	Frank Van Oss	do	14.50
16	5	Ramsay & Jones	Lumber	1343.23
17	6	Hatch & Keith	Timber	381.93
18	7	Major Chas. E. L. B. Davis	Mileage	14.08
31	8	A. Ross Houston	Traveling expenses	14.90
31	9	Hired men	Services	215.00
31	10	C. A. Fuller	do	200.00
31	11	Andrew O'Connell	do	10.00
31	12	William Edwards	do	35.00
31	13	James Clear	do	30.00
31	14	Richard E. Rice	do	30.00
31	15	John Lewis	do	30.00
31	16	Jerry Parkinson	do	30.00
31	17	Gottlieb Jahnke	do	30.00
31	18	Gabriel Wick	do	30.00
31	19	John A. Banker	do	30.00
31	20	George Gifford	do	30.00
31	21	Alexander Sims	do	30.00
31	22	John Baeten	do	30.00
31	23	H. J. Campbell	do	10.00
31	24	Joys, Norris & Co	Duck, etc	26.97
31	25	James Sheriffs	Propeller-wheel	20.00
31	26	Vulcan Iron Works	Shell-sheave, etc	48.93
31	27	Kaukauna Lumber and Maufacturing Company.	Lumber, etc	20.30
31	28	J. H. Marston & Co	Coal	4.63
31	29	Appleton Machine Company	Iron castings, etc	41.70
31	30	H. A. Foster	Oils, etc	22.78
31	31	Schlafer, Barrett & Teach	Packing, etc	13.33
31	32	Howard & Jennings	Iron collar, etc	2.38
31	33	F. M. Davis	Iron, etc	4.83
31	34	Geo. F. Stroud	Oil, etc	4.93
31	35	McKenzie & Crawford	Coal	20.00
31	36	K. M. Hutchinson	Iron, etc	48.81
31	37	Doman & Manual	Globe valve, etc	26.60
31	38	Battin Bros	Assorted steel, etc	492.15
31	39	Williamson & Libbey Lumber Company	Lumber, etc	21.47
31	40	Jas. Gillingham & Son	Guard-rails, etc	3.96

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1889.				
May 31	41	The Morgan Company	Lumber	$274.73
31	42	August Ziemer	Lumber, etc	4.46
31	43	H. Miner	Wall paper, etc	9.35
31	44	H. Stedman	Lumber	27.18
31	45	Berlin & Montello Granite Company	Stone	45.00
31	46	Des Forges & Co	Stationery	37.85
31	47	Ramsay & Jones	Lumber	11.52
31	48	C. A. Fuller	Traveling expenses	13.14
June 5	1	Hired men	Services, May, 1889	2,129.54
5	2	H. S. Sacket	Nails, etc	2.60
5	3	Gerry Lumber Company	Lumber	11.58
5	4	The Cook and Brown Lime Company	Fire-brick	5.00
14	5	Doman & Manuel	Iron castings, etc	618.79
17	6	David Burr	Services	25.00
20	7	George Jarvis	..... do	1.33
28	8	Simons & Tuttle	Iron pipe, etc	4.57
28	9	Butler Bros	Nails	7.50
28	10	Kankauna Lumber and Manufacturing Company.	Lumber	4.34
28	11	Appleton Machine Company	Iron forgings, etc	569.97
28	12	B. T. Gilmore	Rent of office	25.00
28	13	Ramsay & Jones	Lumber	8.00
28	14	James Gillingham & Son	Screw-bolts and washers	11.14
28	15	H. L. Larsen & Co	Oil, etc	35.38
28	16	K. M. Hutchinson	Rope, etc	16.02
28	17	C. C. Paige	Steel bushings, etc	211.70
28	18	S. M. Hay & Bro	Hose, etc	17.90
28	19	S. M. Hay & Bro	Rope, etc	60.27
28	20	McKenzie & Crawford	Coal	138.72
28	21	Chas. S. Morris	.....do	43.65
28	22	F. T Yahr	Wheelbarrows, etc	15.13
28	23	Priest & Garrow	Wood	112.75
28	24	H. K. Priest	Stone	100.00
28	25	Prentice & Mohr	Coal	6.00
28	26	A. J. Weir	Lumber	2.16
30	27	C. A. Fuller	Traveling expenses	31.43
30	28	A. Ross Houston	Services	200.00
30	29	Wisconsin Telephone Company	Rent of telephone	16.15
30	30	C. A. Fuller	Services	200.00
30	31	Andrew O'Connell	.....do	10.00
30	32	William Edwards	.....do	35.00
30	33	James Clear	.....do	30.00
30	34	Richard E. Rice	.....do	30.00
30	35	John Lewis	.....do	30.00
30	36	Jerry Parkinson	.....do	30.00
30	37	Gottlieb Jahnke	.....do	30.00
30	38	Gabriel Wick	.....do	30.00
30	39	John A. Banker	.....do	30.00
30	40	George Gifford	.....do	30.00
30	41	Alexander Sims	.....do	30.00
30	42	John Baeten	.....do	30.00
30	43	Hoffmann and Billings Manufacturing Company.	Labor	1.90
30	44	O. L. Packard	Forge	29.34
30	45	Des Forges & Co	Stationery	56.30
30	46	Hired men	Services	1,890.18
		Total		48,329.62

II 21.

PRELIMINARY EXAMINATION OF CENTREVILLE CREEK, MANITOWOC COUNTY, WISCONSIN.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., November 1, 1888.

SIR: I have the honor to submit the following report of a preliminary examination of Centreville Creek, Manitowoc County, Wis., directed by letter from the Chief of Engineers dated September 29, 1888, in accordance with section 13 of the river and harbor act of August 11, 1888.

Appended herewith is a sketch of Centreville enlarged from the tracing of the original lake survey sheet M, 131, sent with Department letter of October 3, 1888.

Centreville, like so many towns on the west shore of Lake Michigan, having no natural harbor built "bridge-piers," so called, out into the lake. These piers consist of piles driven at pretty wide intervals, sawed off some 8 or 10 feet above the water surface and decked over. Extending out to 12 feet of water they form landing piers for vessels. Being of slight and cheap construction, they are subject to damage by storms, and particularly by ice, so the cost of maintenance is heavy and wharfage charges correspondingly high.

The Goodrich Transportation Company's line of steamers used to stop at Centreville, and at one time all supplies were brought by water, but the building of the Milwaukee, Lake Shore and Western Railway, with a station 1 mile from the village, nearly destroyed the business of the piers, and of the two shown on the sketch but one, the south one, is kept up. The present owner of this pier told me it cost him $4,000, and that $1,600 had been expended for repairs lately, so the wharfage charges must be pretty high as the commerce is small.

Although the lake survey chart was made eighteen years ago, I should say, so far as a cursory examination would enable me to judge, that very little change had taken place since then. As shown on the sketch there is a mill-dam about 700 feet above the mouth of Centreville Creek and 300 feet below the dam a roadway bridge built on piles. Above the dam the water in the creek is ponded back to a depth of 16 feet, but below the dam the creek is very small and shallow, not over 3 or 4 feet deep and 10 or 12 feet wide, with perhaps 18 inches on the bar at the mouth. The mouth is protected by sheet-piling, otherwise the fine drifting sand would at times obliterate the mouth or at least change its position. The amount of water in the creek may be judged from the fact that the grist-mill supplements its water-power by steam, and while I was there the mill was running both its water-wheel and steam-engine, the creek not furnishing sufficient power for the entire mill. It will thus be seen that there is no natural harbor there, and if one is to be furnished it will have to be wholly artificial.

A company has been formed called the Harbor and Dock Association of Centreville, having a State charter granting them the privilege of building wharves, docks, etc., and improving Centreville Creek. The members of this association whom I met during my recent visit stated that they would be satisfied with an available depth of 12 feet, and that all lands required for the purpose of harbor improvement would be deeded free of cost to the Government.

In order to make a harbor at this place it would be necessary to build two piers extending out far enough to obtain 12 feet of water, to dredge

between the piers, and to excavate an interior basin. There is a narrow strip of low land between the foot of the bluff and the lake-shore where a long narrow basin might be excavated, the Centreville Harbor and Dock Company building the necessary wharves and docks of this basin.

The cheapest and best construction of piers for this locality would be pile-piers with double sheet-piling on the lake side to render them sand-proof, like those at Kewaunee, Wis. These piers to reach 14 feet depth of water would be about 1,600 feet long, should be 14 feet wide and 200 feet apart.

An approximate estimate of cost would be as follows:

3,200 linear feet of pile-pier, at $24 per foot	$76,800.00
Dredging channel between the piers, 58,333 cubic yards, scow measurement, at 25 cents per yard	14,583.25
Dredging a basin, above and below the creek, 4 acres, at $7,562.50 per acre.	30,249.00
	121,632.25
Add 10 per cent. for contingencies	12,163.22
Total	133,795.47

I do not think Centreville Creek worthy of improvement, my reasons for such a conclusion being that Centreville Township contains less than 2,000 inhabitants, while the village itself has between 300 and 400 only. The latter has a brewery, grist-mill, lumber-yard, and one or two brick-yards, while the township is mainly devoted to raising dairy produce. During the year 1887 the entire shipments by rail were 4,000 tons of export and 2,000 of import, the former mainly farm products, such as cheese, grain, and cattle. By water the imports and exports for the same period amounted to 2,030 and 740 tons respectively.

Undoubtedly the existence of a good harbor at this place with an available depth of 12 feet would materially reduce railroad freights and therewould be a great increase in the shipment of heavy freight, such as brick, wood, etc., by water. Land being cheap manufacturing industries might spring up, but I do not thing the commerce present or prospective would warrant the expenditure of so large a sum as $133,000.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

I I 22.

PRELIMINARY EXAMINATION OF KENOSHA HARBOR, WISCONSIN, FOR REFUGE.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., October 20, 1888.

SIR: I have the honor to submit the following report of a preliminary examination made by myself October 16, 1888, of Kenosha Harbor, Wisconsin, "for refuge," as called for by section 13 of the river and harbor act of August 11, 1888.

Calling on the harbor committee of the Business Men's Club of Kenosha, to whose active efforts the insertion of this clause in the river and

harbor act was due, I found that it was their wish to have the examination confined exclusively to the "inner harbor" as it is called.

The inner harbor, as shown on the accompanying tracing, includes all the part to the westward of the inshore ends of the piers as far as the bridges over "the Basin" and Pike Creek respectively, an area comprising about 14 acres, and, with the exception of portions dredged by private enterprise in front of the wharves, having an average depth of some 5 feet. The entrance to this harbor is through two approximately parallel piers, 150 feet apart at the shore-line and 170 feet at the lake ends, with a channel between, now in process of being dredged out by contract to a depth of 15 feet.

This narrow entrance of 170 feet I consider an insuperable objection to the use of this inner harbor for purposes of "refuge." In order to give "fully and particularly the facts and reasons" on which I base my opinion, I submit the following brief account of the entrance-widths of harbors of refuge on the Great Lakes:

At Oswego, on Lake Ontario, the eastern arm of the outer breakwater was commenced 351 feet from the western arm; this width has been found to be entirely inadequate and the cause of much complaint on the part of vessel-men, so that the local engineer has recommended the removal of the portion so far built, and the Board of Engineers of February 15, 1887, has concurred in this recommendation.

At Buffalo, on Lake Erie, the breakwater being parallel to and two-thirds of a mile from shore, the entrance width is practically unrestricted, there being nearly half a mile between the end of the Buffalo River pier and the adjacent end of the breakwater.

At Cleveland, on the same lake, the proposed east breakwater is to leave an entrance of 500 feet between it and the lake arm of the west breakwater.

At Sand Beach, on Lake Huron, the main or south entrance is 600 feet wide and the north entrance 300 feet, the latter, however, merely intended to facilitate the passage of outward-bound vessels, make a current to move the ice, etc.

At Michigan City, on Lake Michigan, the approved project calls for an entrance of 400 feet.

At Milwaukee, the southern entrance, in case it is found necessary to build a southern arm, is to be 1,000 feet wide, the northern opening 400 feet, the smaller opening being for the same purpose as at Sand Beach.

At the entrance of the Sturgeon Bay Ship Canal the width between the outer piers was originally but 235 feet. This was found to be so inadequate that two detached piers, 150 feet long and so placed as to increase the width to 335 feet, were built. This entrance is still complained of as too small.

At Grand Marais, Mich., on the south shore of Lake Superior the width between the entrance piers is to be 500 feet.

At the Lake Superior entrance of the Portage Lake Ship Canal the Board of Engineers of December 22, 1886, recommended a new entrance 400 feet in width.

At Grand Marais, Minn., the proposed pier extension still leaves a clear opening of over 400 feet.

It will therefore be seen that 400 feet is the minimum width of opening where the entrance is at right angles to a line of breakwater, and that in the only two cases where the entrance is between parallel piers, Sturgeon Bay and Grand Marais, Mich., the widths are 335 and 500 feet respectively, the former of which has been found too restricted.

Two ways suggest themselves to remedy the defect of a too narrow entrance: First, to prolong the piers on divergent lines until the proper width is attained; and, secondly, to build parallel piers the proper distance apart, removing one of the present piers for this purpose. The first method would give a flaring, funnel-shaped harbor entrance, one of the worst possible forms, and entirely inadmissible; the second is also inadmissible, because the inclosed basin is too small to sufficiently reduce the large waves that could pass through a wide entrance, the reductive power of the basin with an entrance of 500 feet being only about four-tenths.

With reference to the cost of dredging out the inner basin to the same depth as the channel entrance, 15 feet, it would require the removal of about 204,000 cubic yards of material, scow measurement. The contract price of the present dredging now being done at Kenosha being 19 cents, I think 15 cents would be a fair figure for inside work, making a cost of $30,600, which, with the usual contingencies, would amount to about $34,000. This dredging would be a great benefit to the local commerce of the place, although it would not make it a harbor of refuge. It might be a question as to whether the local authorities should dredge this interior basin or the Government, though there are precedents for such work being done by the Government in this district, notably at Port Washington, where two interior basins of a combined area of 5¾ acres and a depth of 12 feet have been dredged out at the mouth of the Sauk River, though the purposes subserved are almost entirely local.

With regard to an exterior harbor of refuge at Kenosha, the breakwater would have to be located in from 5 to 6 fathoms of water to obtain sufficient anchorage room, as shown by the lake survey charts, so that the conditions are quite similar to those obtaining at Milwaukee. The present project at Milwaukee is estimated at $800,000, so a rough estimate for a somewhat similar but perhaps smaller one at Kenosha would call for at least $500,000. I do not think the commercial interests to be subserved would warrant the expenditure of so large a sum.

With reference to harbors of refuge on the lakes, it may be said that the general tendency is to build larger vessels, and when the lighter draught vessels become unserviceable they are replaced by new ones of much greater capacity, owing to the increased depths in the Detroit River and the Sault. These large steam-propelled barges can ride out most of the lake storms, and will seldom stop to seek a refuge, but continue on to their destination, leaving the harbors of refuge to be sought by the smaller sailing craft, a yearly diminishing portion of the lake marine.

I therefore do not think Kenosha Harbor is worthy of improvement "for refuge."

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

I I 23.

PRELIMINARY EXAMINATION OF OCONTO HARBOR, WISCONSIN, CHANNEL SIXTEEN FEET DEEP AND SEVENTY-FIVE FEET WIDE FROM PIERS TO FIRST CONTOUR IN RIVER AT SPIES SLOUGH.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., November 23, 1888.

SIR: I have the honor to submit the following report of a preliminary examination of Oconto Harbor for a channel 16 feet deep and 75 feet wide from piers to first contour in river at Spies Slough, directed by letter of the Chief of Engineers of September 29, 1888, in accordance with section 13 of the river and harbor act of August 11, 1888.

I transmit herewith a map of Oconto Harbor, showing the piers and the Oconto River as far as the Section Street Bridge, in the city of Oconto.

The approved project for the improvement of this harbor is for a channel 8 feet deep and 100 feet wide from the Section Street Bridge, in Oconto, to the shore-line in Green Bay, a distance of about 2 miles, and the extension of this channel to the 10-foot contour in Green Bay by means of two parallel piers 150 feet apart, these piers being built in continuation of the slab-piers built by the city of Oconto.

A survey of the mouth of Oconto River was made under the direction of Maj. D. C. Houston, Corps of Engineers, in 1870, who reported that general commerce and navigation would not be benefited by a harbor at this point. This seems to have been the opinion of all the engineer officers who have since had charge of this harbor, but the people of Oconto have been very persistent, until finally the present project, just described, was determined upon at an estimated cost of $150,000.

The project now called for in the preliminary examination is for a channel 16 feet deep and 75 feet wide from the piers to Spies' Mill, a distance of 6,000 feet. The wording of the act is "to the first contour in Spies' Slough," but a personal interview with those who were instrumental in getting the clause calling for this examination inserted in the river and harbor bill brought out the fact that Spies' Mill was intended as the limit of the channel.

For the first 1,000 feet or more the piers at the mouth of the river are constructed of two rows of piles 20 feet apart, the piles in each row being driven 5 feet between centers, and filled with slabs and edgings fastened down by binding-poles at right angles to the axis of the pier. As deeper water was reached a stronger method of construction was used, the piles being driven 4 feet apart on the channel side and 2 feet apart on the outside, with waling timbers, cross-ties, and rods, and a riprap of stone on the exposed side.

The piles were driven but 10 feet into the bed of Green Bay, and as the depth of water for a long distance out was but 3 feet the bottoms of the piles are only 13 feet below the water surface; consequently, if a channel of 16 feet is made the bottom of the channel will be 3 feet below the points of the piles. The piers being but 150 feet apart I do not think it would be safe to attempt to make a 16-foot channel between them, and therefore I am of the opinion that one of the piers should be removed and rebuilt at least 250 feet from the remaining pier. The north pier, being the shortest, least exposed, and slightest in construction, should be the one selected for removal.

The Oconto River, below the city of Oconto, is at ordinary stages a sluggish stream flowing over a wide marsh, but during the spring

freshets it pours out a considerable volume with a strong current, which, following the natural circuitous course of the river, has a tendency to obliterate the shortened dredged channel, shown on the map in red. At present 7 feet can be carried through with the exception of a shoal place near the piers, where there is but 6 feet. The dredged channel would have to be revetted at the points where it crosses Spies' Slough, and also at the mouth of a slough farther down-stream, or at the points marked in red ink "a," "b," and "c." I do not think 75 feet is wide enough for a channel of the proposed depth, 16 feet, for, being on an average some 9 feet below the present depth of the river, in soft material, there would be a constant tendency to fill up, and it would be only a question of time when a widening would be called for.

The Lake Shore and Western Railroad has a terminus to the northward of Spies' Mill, just below the highway, and the parties interested in this improvement propose this channel for the purpose of connecting with this road, intending to build docks and wharves in the vicinity; but it seems to me a much cheaper solution of the problem would be to extend the railway down to the mouth of the river, building the wharves and landing-docks just inside of the piers. The extension of the railroad over the marsh seems to present no peculiar difficulties.

It is claimed that this proposed improvement would be of great advantage to the back country tributary to Oconto; that by this means this portion of the State could get supplies, particularly coal, at much reduced rates; but the return freights would certainly be small, while the building of branch railroads from Green Bay, Wis., and Menominee, Mich., will open up this country and furnish it with harbor facilities much greater than there can ever be at Oconto.

To provide for a 16-foot channel will require an extension of the south pier of 1,100 feet, the rebuilding of the inshore end of this pier, and the removal and rebuilding of the north pier, all as shown in red on the map.

The following is the approximate of the cost of a channel 75 feet wide at the bottom and 16 feet deep, extending from the 16-foot contour in Green Bay to Spies' Mill.

Extension of the south pier 1,100 feet, at $20	$22,000
Repairing and re-enforcing 500 feet of the shore end of the south pier, at $8	4,000
Removing and rebuilding the present north pier 1,600 feet, at $10	16,000
Extending the north pier 1,900 feet, at $20	38,000
Dredging 500,000 cubic yards, at 15 cents	75,000
Revetting 1,200 linear feet of the channel in the river, at $8	9,600
	164,600
Add 10 per cent. for superintendence and contingencies	16,400
Total	181,000

To this should be added the amount expended up to date, approximately $50,000, making a total expenditure on this harbor of $231,000. This is a small estimate, and the cost of maintenance would be heavy.

Considering the present and prospective commerce that might arise in consequence of this improvement, I do not think the Government would be warranted in expending such a large sum for the improvement of this harbor, and I therefore do not consider the harbor worthy of improvement in accordance with this enlarged plan, and I recommend that no change be made in the present plan of improvement.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

II 24.

PRELIMINARY EXAMINATION OF RACINE HARBOR, WISCONSIN, WITH A VIEW TO ENLARGING AND DEEPENING CHANNEL.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., October 20, 1888.

SIR: In accordance with instructions contained in letter from the office of Chief of Engineers, dated Washington, D. C., September 29, 1888, I have the honor to submit the following report of a preliminary examination of Racine Harbor, Wisconsin, called for by section 13 of the river and harbor act of August 11, 1888.

This section called for an examination with a view to "enlarging and deepening the channel."

The appropriation passed by the act of August 5, 1886, for this harbor was expended in rebuilding the badly decayed superstructure over the outer section of the south pier; the channel had then been dredged to 16 feet, but was only 75 feet in width. The following year, there being no appropriation of funds for maintaining this channel, it rapidly deteriorated, owing to its slight width, until the available depth for navigation was only about 12 feet, vessels drawing 13 feet striking on the bottom.

This shoaling was made the subject of a communication of Mr. Simeon Whiteley, secretary of the Racine Business Men's Association, to the Hon. Philetus Sawyer, United States Senate, dated May 20, 1888, which was referred, through the Chief of Engineers, to Capt. W. L. Marshall, then in charge of the harbor. The Chief of Engineers also, in a letter dated August 22, 1888, "in view of the immediate and pressing demands for a deeper channel," called upon me for a separate communication, which was sent under date of August 28, 1888.

The present project for the improvement of this harbor, under the river and harbor act of August 11, 1888, approved by indorsement of the Chief of Engineers dated August 31, 1888, calls for a channel 16 feet in depth and 150 feet in width, to be dredged the whole length of the piers forming the harbor entrance. This dredging is now being done under a contract entered into October 9, 1888, with Christopher H. Starke, of Milwaukee, Wis., and it is thought that the entire 38,000 cubic yards will be removed before the close of navigation.

In my opinion, the completion of this contract will give the needed relief by "enlarging and deepening the channel," as called for by the aforesaid section of the river and harbor bill.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX J J.

IMPROVEMENT OF CHICAGO AND CALUMET HARBORS, ILLINOIS, AND OF ILLINOIS AND CALUMET RIVERS; LOCATION OF ILLINOIS AND MISSISSIPPI CANAL.

REPORT OF CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Chicago Harbor, Illinois.
2. Calumet Harbor, Illinois.
3. Illinois River, Illinois.
4. Calumet River, Illinois and Indiana.
5. Location of Illinois and Mississippi Canal.

EXAMINATIONS.

6. Grand Calumet River, Indiana, beginning one-half mile east of Hammond, and thence eastward to Lake Michigan.
7. Canal-way connecting the waters of Lake Michigan with the Calumet River, beginning at a point on the Calumet River 1 mile east of Hammond, Indiana, and running due north to Berry Lake, and thence along the eastern waters of said Berry Lake; thence northeast to Lake Michigan.
8. Berry Lake, Indiana, forming a natural harbor of refuge.
9. Grand Calumet River, Illinois.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 10, 1889.

SIR: I have the honor to transmit herewith annual reports upon the works in my charge during the fiscal year ending June 30, 1889.

* * * * * * *

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

give relief to the over-crowded river.

(*b*) The construction of an exterior breakwater of crib work fil with stone outside of the outer harbor in deep water to shelter t entrance to Chicago River and outer harbor from northerly storms, a to form a sheltered area or harbor of refuge at the southern end Lake Michigan.

In addition to this incomplete project, the entrance to Chicago Riv which is protected by piers built by the United States, is to be ma tained, both piers and channel.

CONDITION OF THE WORK JUNE 30, 1889.

Outer harbor.—This basin, south and east of the present mouth Chicago River, covers about 455 acres in area. A dock and wharf-li was established by special order, Corps of Engineers, No. 108, Augu 3, 1871, at about 1,300 feet east of the shore-line, and parallel to an about 2,000 feet west of the breakwater that limits the basin to th eastward. Between the dock-line and breakwater an area of 270 acr is included, which the original project contemplated dredging to 16 fe in depth, where deficient in depth. The area between dock-line an shore is reserved for docks and slips. Two hundred and sixty-seve thousand cubic yards of material is yet to be dredged from the oute basin beyond the dock-line, but as this material will be valuable fo filling should the outer basin be used for wharves and docks, and inas much as the area already dredged is adequate for present needs, a com pletion of the work of dredging at this time is not advisable or nece sary.

The piers inclosing this harbor have been completed for years; but portion of the southerly breakwater was damaged by storm Decembe 4, 1885, and requires reconstruction. This gap has not enlarged sinc the damage was done, and is practically of little importance, but is u sightly.

The superstructures of the north pier and easterly breakwater of th outer basin are rotten, and now urgently require rebuilding over an ex tent of 4,738 linear feet. They should be rebuilt in a permanent manne

Exterior breakwater.—The work is situated 1 mile northeast of the mouth of Chicago River, the entrance to which it covers from northerly storms. It is to be 5,436 feet in length.

During the past fiscal year, in accordance with the approved project for the expenditure of the appropriation made for improving Chicago Harbor, contained in the river and harbor bill of August 11, 1888, proposals were solicited for completing 1,200 linear feet, more or less, of substructure, and for raising to a greater height 400 linear feet of superstructure over cribs that had settled. The proposals were received and opened October 10, 1888.

With the approval of the Chief of Engineers, contract for this work was entered into October 31, 1888, with the Fitz Simons and Connell Company, the lowest responsible bidders, who have prosecuted the work satisfactorily and vigorously. Up to the close of the fiscal year ending June 30, 1889, the contractors have completed the superstructure work required by their contract, viz, 400 linear feet over old work, and have sunk in place upon a stone foundation six cribs, extending the substructure of the piers 408 linear feet. There remains to be constructed, to complete the breakwater, 748 linear feet of substructure (now under contract) and 1,156 linear feet of superstructure (yet to be contracted for), the necessary funds for which latter work are now available.

This breakwater answers the purpose for which it was constructed, and its value as a harbor of refuge and as an aid to navigation, is conceded by all persons interested in lake commerce.

Entrance to Chicago River.—At the beginning of the fiscal year the entrance to the Chicago River (Chicago Harbor proper) had deteriorated until there was an available channel less than 15 feet deep at mean lake level. In places there was a depth of less than 12 feet in the channel.

Sealed proposals were solicited and opened September 25, 1888, for restoring this channel to its proper depth of 16 feet at low water. With the approval of the Chief of Engineers, a contract was entered into with Frank R. Crane, September 29, 1888, the lowest responsible bidder. The work was begun October 1 and completed November 6, 1888, during which time 25,282.4 cubic yards of sand were removed from the channel. No further difficulty has been experienced by vessels entering the harbor of Chicago at this point since the dredging was done.

In addition to the work of construction above described, the boats and plant belonging to the United States were repaired and kept in serviceable condition, and lights were maintained upon the exterior breakwater during the season of navigation, 1888.

For the season of navigation, 1889, a light-ship has been substituted for the lights heretofore maintained directly upon the breakwater. It is moored near the southeastern end of the structure, and gives satisfaction to mariners.

For details of this work see the accompanying report of Mr. G. C. Almy, overseer.

PROPOSED APPLICATION OF FUNDS NOW AVAILABLE.

The funds now available are to be applied to the completion of the exterior breakwater and to repairing the break in the southerly breakwater of the outer basin, and for lighting the exterior breakwater. They will be sufficient for these purposes.

PROPOSED APPLICATION OF FUNDS ASKED FOR FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

The funds asked for for the fiscal year ending June 30, 1891, are to be used in completing the outer basin and in replacing with permanent work the rotten superstructure over the north pier at the entrance to Chicago River and over the easterly breakwater of the outer basin throughout its entire extent.

Money statement.

July 1, 1888, amount available		$2,933.30
Received from sale of fuel to officer		24.75
Amount appropriated by act of August 11, 1888		200,000.00
		202,958.05
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$55,568.41	
July 1, 1889, amount covered by existing contracts	82,197.52	
		137,765.93
July 1, 1889, balance available		65,192.12
Amount (estimated) required for completion of existing project		172,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		172,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

The amount reported as available July 1, 1888 ($2,761.30) is found to have been in error, being $172 too small.

Abstract of proposals for dredging at Chicago Harbor, received and opened at Chicago, Ill., September 25, 1888, by Capt. W. L. Marshall, Corps of Engineers.

No.	Name and address of bidder.	Dredging 20,000 cubic yards (estimated), per cubic yard.	Total.
		Cents.	
1	The Fits Simons and Connell Company, Chicago, Ill	19	$3,800
2	Green's Dredging Company, Chicago, Ill	19½	3,900
3	Frank R. Crane,* Chicago, Ill	13½	2,700

* Accepted and contract made, dated September 29, 1888.

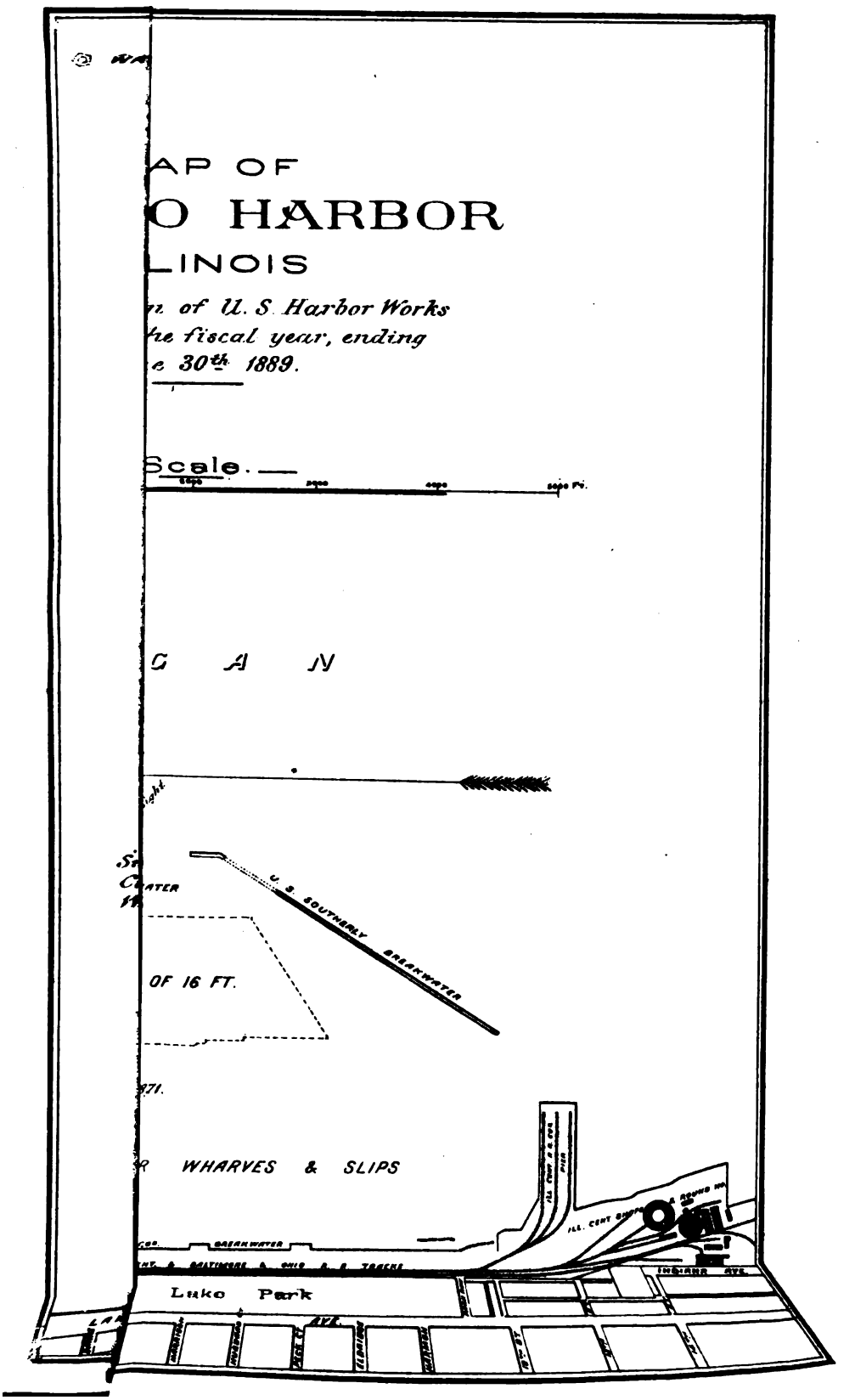
Abstract of proposals for extending the exterior breakwater at Chicago Harbor, Ill.

[Received and opened October 10, 1888, by Capt. W. L. Marshall, Corps of Engineers.]

	No. 1. The Fitz Simons & Connell Co., Chicago, Ill.*	No. 2. Hiero B. Herr & Co., Chicago, Ill.	No. 3. Chicago Dredging and Dock Co., Chicago, Ill.
Hemlock timber, 102,312 feet, B. M., per M feet	$13.00	$13.00	$15.00
Pine timber, 17,391 feet, B. M., per M feet	17.50	16.00	21.00
Pine plank, 4,900 feet, B. M., per M feet	15.00	14.00	18.00
Iron drift-bolts, 10,113 pounds, per pound	.05	.04	.06
Iron screw-bolts, N. and W., 228.47 pounds, per pound	.07	.04	.07
Spikes, 841.18 pounds, per pound	.05	.04	.06
Stone, 576,647 cords, per cord	6.00	6.80	7.00
Framing, 119,703 feet, B. M., per M feet	10.00	8.75	16.00
Laying plank, 4,900 feet, B. M., per M feet	4.00	6.00	6.00
Taking up plank, B. M., per M feet	4.00	.....	6.00
Total amount for 68 feet (1 crib)	6,948.11	7,122.23	8,642.51
Total amount for 1,156 feet (equal 17 cribs)	118,117.87	121,077.91	146,922.61

* Accepted, and contract made, dated October 31, 1888.

NOTE.—There is no plank to be taken up, and this item is omitted from the total estimated cost.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O HARBOR
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n of U. S. Harbor Works
he fiscal year, ending
e 30th 1889.
Scale.
G A N
U. S. SOUTHERLY BREAKWATER
OF 16 FT.
WHARVES & SLIPS
BREAKWATER
Luko Park
INDIANA AVE.

Abstract of contracts for improving harbor at Chicago, Ill., in force during the fiscal year ending June 30, 1889.

Contractor.	Nature of contract.	Date.	To expire—
Frank R. Crane, Chicago, Ill.....	Dredging between harbor piers.	Sept. 29, 1888	*Nov. 30, 1888
The Fitz Simons and Connell Company, Chicago, Ill.	Extending exterior breakwater and building superstructure.	Oct. 31, 1888	Oct. 31, 1889

*Completed November 6, 1888.

REPORT OF MR. G. C. ALMY, OVERSEER.

EAST BREAKWATER, *Chicago Harbor, July* 1, 1889.

SIR: I have the honor to submit the following report of operations for the improvement of this harbor during the fiscal year of 1888 and 1889, in accordance with your instructions of June 6, 1889.

Orders for the preliminary work of repairing tug and stone scows, to fit them for service, were received September 4, and a suitable force was immediately employed for the performing of such part of the work as was possible without docking. September 14, an agreement was entered into with the Chicago Dry Dock Company for certain work of calking, etc., of the bottoms of the tug and three of the scows, which could only be done in dock. The dock work was satisfactorily completed, and the craft returned to the breakwater September 20. The remaining work on the tug, including slight repairs to the boiler, executed under an agreement with John Mohr & Son, at a cost of $125, was finished September 24.

The scows under repair at this time by the hired force were Nos. 1, 2, 3, 5, and 6. Nothing was done on No. 4, notwithstanding the deck was in need of renewal; but being otherwise serviceable, it was believed that by careful management and moderate loading the boat might be used during the short time remaining of the working season without serious risk.

The work performed by the hired force on the above-named craft consisted of repairs to the planking of the sides, ends, and decks; partial renewal of the upper chime pieces, bucking beams, hatch coamings, and timber-heads, together with the necessary calking. The first scow was ready for service September 26 and the last on October 6. As fast as completed they were put to use for transporting stone to South Chicago.

Through the months of September, October, and November considerable incidental work was performed for various purposes, including sounding, and the making of buoys and sounding poles for the dredging, making camp furniture for the canal survey party, repair of yawl-boat, etc.

As the repairs to scows approached completion the force was transferred to the work of crib construction. Framing, by a party of ship-carpenters under Master-Carpenter John Bloom, began October 3, and crib building, by a properly organized gang under Foreman Edward Healy, October 8. The working force at this time comprised the two foremen above mentioned, 12 carpenters, 7 bolters, 9 laborers, and 1 blacksmith. Six men left or were discharged before the close of the month. There were also on duty the crew of the tug and the usual watchmen.

Four cribs for closing the gap in the south breakwater, each 100 feet long, 16 feet wide, and 10 courses high, were built, and the force discharged November 3, except six men retained for the work of breaking up the wrecked cribs by blasting and miscellaneous duty attendant upon the close of operations for the season.

The material expended for the construction of the above cribs comprised 206,888 feet, B. M., hemlock timber, and 20,882.05 pounds drift-bolts.

As the season advanced the weather became rough and unfavorable for the work remaining to be done at the south breakwater. An examination of the overturned cribs, commencing November 5 and concluded the following day, by the diver and assistants, was made, to ascertain their exact position and condition, and the best method of placing cartridges for the removal of the wreck and clearing the line for the new cribs. Several days ensued during which the state of the sea prevented the commencing of the blasting; but on the 12th of November it was begun, and continued until the four boxes of 1¼-inch cartridges (forcite) were expended, when the work ceased until a further supply of forcite, which was immediately ordered, could be delivered. During the day fourteen blasts were made, about a dozen cartridges

being fired each time, after being placed closely in contact with the cribs. As far as could be seen the cribs were badly shattered, but below the surface of the water the actual effect could not be fully determined. On the 14th the blasting was resumed, and finished the following day.

Upon the last day two charges of about 60 pounds each were exploded under the opposite ends of a crib, where they were placed by the diver. These heavy charges were fired separately, and with each explosion the whole crib appeared to rise several feet, being covered with a great volume of water resembling a hill at least 25 feet in height. In all, 600 pounds of forcite were expended, in charges varying from 6 pounds to about 60 pounds, proportioned to the apparent mass and strength of the wreck at the points where applied. All that portion of the old crib-work that seemed likely to obstruct the placing of new cribs was in this manner thoroughly broken up, and though some of the timber is yet held in place by the weight of stone surrounding or covering it, it is believed that the operations of the dredge in leveling the stone to form the new foundation, aided by the action of the sea, will release and accomplish its complete removal.

With the conclusion of this work (November 15) the six workmen who had been retained for the purpose were discharged, leaving on duty only the crew of tug and necessary watchmen. The tug was employed until December 20 for the care of signal lights at exterior breakwater and other service, when orders to cease work and lay up for the winter were received. The crew was paid off December 31.

DREDGING.

Extending eastwardly from a point a short distance below Central Slip, towards the mouth of the river, nearly to the entrance of Light-house Slip, there had been through a long term of years a gradual accumulation of muddy deposit, forming a group of banks, between which the channel was narrow and tortuous, and constituting a serious obstruction to the free navigation of the river by the larger vessels, which were constantly grounding and subjected to expensive and annoying detention.

For the removal of this impediment to commerce a contract, dated September 29, 1888, was entered into with Mr. Frank R. Crane, of Chicago, by the terms of which the necessary dredging was to be performed at the rate of 13½ cents per yard. The work was begun October 1 and finished November 6, during which time there was removed 25,282.4 cubic yards of material. This work for the widening and deepening of the channel proves every day its practical value, admitting, as it does, of the free passage of all vessels having business at this port, and effecting an important saving of time and tug bills. No vessel has been detained by grounding in this vicinity, so far as known, since the dredging was completed.

EXTERIOR BREAKWATER.

Operations for extending this work to its eastern limit, as provided for by the plan (a distance of about 1,200 feet) and in accordance with the project last approved by the Chief of Engineers, were commenced under the contract with The Fitz Simons and Connell Company, of Chicago, March 11, 1889.

On the date mentioned a quantity of stone was deposited at the east end, on the line of the breakwater, at the beginning of the foundation for the new cribs. Framing began March 18. Work for the rebuilding of the superstructure over the four cribs placed on the east end of the breakwater during the months of May and June, 1887, which was required by reason of the excessive settling of this portion of the structure, commenced March 22, and was completed May 4, except the stone filling, which was not finished until May 21. The following statement shows the expenditure of material and cost on account of

REBUILDING SUPERSTRUCTURE.

Pine timber, 102,716 feet, B. M. at $17.50	$1,797.53
Drift-bolts, 11,801.09 pounds, at 5 cents	590.05
Stone, 576.57 cords, at $6	3,459.42
Spikes, 300 pounds, at 5 cents	15.00
Total	5,862.00

The building of the first new crib (No. 44) began March 25, 1889. Up to the end of the fiscal year six cribs have been completed and sunk in position, five of which are accepted and paid for. One other crib (No. 50) is ready to sink and three more

well advanced in their construction. The stone filling of the crib last sunk (No. 49) is not yet finished.

The new cribs are each 68 feet long, 30 feet wide, and 27 courses high. They are placed upon a foundation of rubble stone 40 feet wide on top, and about 7 feet in depth. The depth of water on the line of the extension is now 32 feet, and no deeper soundings between the present end of the work and the point where it will terminate are found.

The cribs just sunk have added 408 feet to the previous length of 4,236 feet, making the total length of the breakwater at the close of the fiscal year 4,644 feet.

The placing of eleven other cribs is required to carry the work to its eastern terminus. From the successful progress already made, there is ample reason for the expectation that this will be accomplished within the time named in the contract, and there is the further gratifying assurance that, under the new project upon which this part of the work is being performed, it will, when finished, constitute decidedly the most substantial and sightly portion of the breakwater. It is, perhaps, to be regretted that the entire structure could not have been built upon the plan now in force. In cost, reliability, and appearance, the results would certainly have been much more satisfactory.

The new method, adopted at the beginning of the present season of navigation, of locating the east end of the breakwater at night by means of a light-ship, has met, as far as can be learned, with the approval of all concerned. No complaints from any source have been heard as to the sufficiency and value of the light as now maintained.

REPAIRS TO SUPERSTRUCTURE.

Under date of April 26, 1889, a "special agreement" with the Fitz Simons and Connell Company, of Chicago, was entered into for certain repairs to the superstructure at the junction of Cribs 39 and 40, made necessary by the continued settling of the superstructure of the latter crib, whereby a considerable opening was caused between it and the superstructure, making a weak place at that point, which required proper attention before the aperture should be enlarged by the sea and a long stretch of superstructure endangered.

This work was begun May 6 and finished May 20, with the expenditure of labor and material for its completion as follows:

Old timber removed, 18,912 feet, B. M., at $10	$189.12
Stone removed, 26 cords, at $3	78.00
New timber (pine) framed and secured, 30,996 feet, B. M., at $30	929.88
Drift-bolts, 3,825.02 pounds, at 5 cents	191.25
Total	1,388.25

DREDGING AT SOUTH BREAKWATER.

During a severe storm on the night of December 4, 1885, several cribs forming a part of the south breakwater were overthrown and destroyed, leaving a gap in the work about 400 feet in length.

By the wrecking of these cribs the line throughout the length of the break was left obstructed by a mass of stone and timber, over which the water varied in depth from 3½ to 8 feet. The natural depth in this locality is 17½ feet.

Preparatory to the closing of the gap with new cribs, as it is designed to do this summer, an arrangement was concluded with the Fitz Simons and Connell Company, of Chicago, for the services of a dredge to be employed in the leveling or removal of the débris.

This work was commenced June 20, and finished June 29, 1889. The area cleared includes the whole length of the break, with ample width for the new cribs, which are 16 feet, and a depth not less than 13 feet. There is nothing to prevent the construction of the new work at once.

Respectfully submitted.

G. C. ALMY,
Overseer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The nearest collection district is Chicago, Ill. The nearest port of entry is Chicago, Ill. Amount of revenue collected at the nearest port of entry during the last fiscal year, $4,966,198.72.

Port of Chicago.	Number.	Tons.
Vessels arrived	10,400	4,344,540
Vessels cleared	10,538	4,467,536

Receipts and shipments by lake during the calendar year 1888.

Articles.	Quantity.	Articles.	Quantity.
RECEIPTS.		SHIPMENTS.	
Coal.....tons..	1,363,421	Flour.....barrels..	1,711,370
Lumber.....feet..	1,626,408,000	Grain.....bushels..	66,894,067
Iron.....tons..	157,320	Lard.....pounds..	45,904,670
Merchandise.....packages..	6,277,463	Lead.....pigs..	117,372
Posts, railroad ties, and telegraph poles.....number..	6,662,712	Iron, miscellaneous.....tons..	2,216
Wool.....pounds..	141,100	Merchandise, miscellaneous, packages.....	1,479,947
		Wool.....pounds..	1,620,000

JJ 2.

IMPROVEMENT OF CALUMET HARBOR, ILLINOIS.

The object of the work is to provide a deep entrance to Calumet River and the port of South Chicago.

This is effected in the usual manner by dredging a channel and protecting the dredged area by parallel piers 300 feet apart, projecting into the lake from the river's mouth.

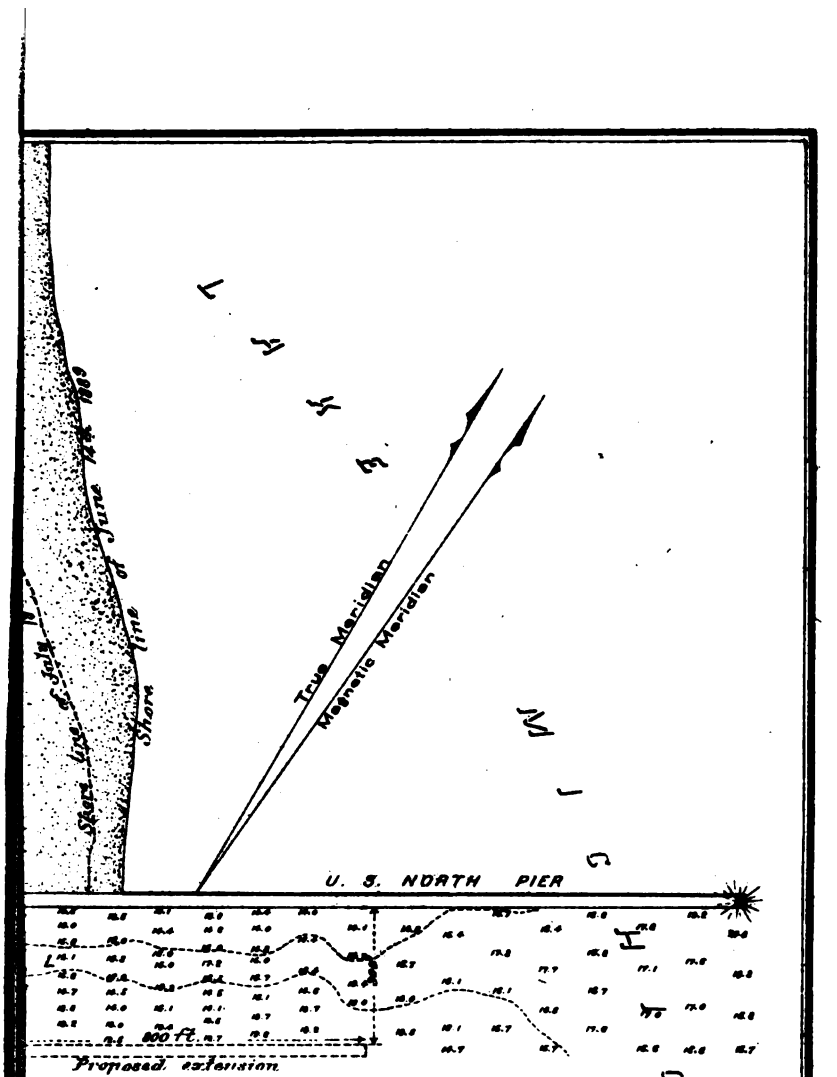
CONDITION OF THE WORK JUNE 30, 1889.

Work was begun on this harbor in 1870, and at the beginning of the fiscal year 1889 there had been completed 1,870 feet of the south pier and 3,640 linear feet of the north pier, making a total length of pier-work of 5,510 linear feet.

As soon as the appropriation for this harbor was made available, under the project approved by the Chief of Engineers, sealed proposals were solicited by advertisement for constructing 150 linear feet of the south pier to complete the existing project, which proposals were received and opened October 10, 1888.

With the approval of the Chief of Engineers a contract was entered into October 30, 1888, with Hiero B. Herr & Co. for this work. Under this contract work was begun May 1, 1889, and completed before the close of the fiscal year.

Owing to the lateness of the season when the appropriation of August 11, 1888, became available, and the unsafe condition of portions of the north pier and of the beacon-light tower thereon, due to insufficient stone filling, authority was sought and obtained from the Chief of En-



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gineers to purchase the necessary stone filling in the open market and o place it at once by hired labor; 922.15 cords of stone were obtained nd placed in this manner before November 26, 1888.

At the close of the fiscal year 1889 the total length of the north pier s 3,640 linear feet, and of the south pier 2,020 linear feet, or 5,660 linear eet of pier-work in all. The project has been completed so far as the ier-work is concerned, but the south pier should be prolonged 800 near feet farther, to protect the channel from drifting sands.

On account of the urgent necessity for maintaining the work already one, the superstructure of the piers being rotten over an extent of 1,600 near feet and the depth of water in the channel having deteriorated ince the last dredging was done, the estimate submitted herewith is ntirely for maintenance of work already done, and contemplates no rther extension of piers at the present time.

The channel is insufficient to accommodate the heavily-laden ore vessels hat must use this harbor, and it has been necessary for the rolling-mill ompanies and private parties to dredge in the channel to relieve the ituation. There is still necessary, however, to give a channel to the full idth and depth of 16 feet, some 76,000 cubic yards of dredging, at an stimated cost of $21,000.

There is a demand for an increase of this depth to 18 feet, to accom- odate the constantly-increasing size and draught of lake vessels. To ive the increased depth requires further dredging to the amount of 2,000 cubic yards, in addition to that required to give a depth of 16 eet. A project for the extension of the south pier and increasing the epth to 18 feet will be submitted when the now urgent work above pecified shall have been provided for. For details of this work, see the ccompanying report of Mr. G. A. M. Liljencrantz, assistant engineer.

ROPOSED APPLICATION OF FUNDS NOW AVAILABLE AND ASKED FOR FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

It is proposed to apply these funds in dredging the channel and in ebuilding superstructure over 800 linear feet of each pier.

Money statement.

uly 1, 1888, amount available	$777.70
mount appropriated by act of August 11, 1888	20,400.00
	21,177.70
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	16,170.91
July 1, 1889, balance available	5,006.79
Amount (estimated) required for completion of existing project	47,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	47,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for extending the south pier, at Calumet Harbor, Illinois, received and opened October 10, 1888, by Capt. W. L. Marshall, Corps of Engineers.

	No. 1.* Hiero B. Herr & Co., Chicago, Ill.	No. 2. The Fitz Simons & Connell Co., Chicago, Ill.
Hemlock timber, 66,311 feet, B. M., per 1,000 feet	$23.00	$28.00
Pine timber, 22,920 feet, B. M., per 1,000 feet	26.00	33.00
Pine piles, 32 feet each	12.00	12.00
Iron drift-bolts, 7633.58 pounds, per pound	.04	.07
Iron screw-bolts, 400.06 pounds, per pound	.05	.08
Iron spikes, per pound	.05	.07
Stone, 182,993 cords, per cord	2.00	2.00
Total for 75 feet of work (equal 1 crib)	4,477.35	5,276.07
Total for 150 feet of work (equal 2 cribs)	8,954.70	10,552.14

*Accepted, and contract made, dated October 30, 1888.

NOTE.—The item of spikes is not included in the total estimates, as the amount to be used, if any, will be small, and is not now known.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 1, 1889.

CAPTAIN: I have the honor to submit herewith a report on Calumet Harbor, Illinois, for the fiscal year ending June 30, 1889.

Owing to the lateness in the season of the passage of the river and harbor bill, August 11, 1888, no work was done in the fall in this harbor, save the refilling with stone of portions of the north and south piers. It had become of utmost importance to have this work done without delay, the settling of the stone in the cribs having taken place to such an extent as to seriously endanger the structures in case of heavy storms, and more particularly the more-exposed north pier, with the beacon light at the outer end thereof. Bids were therefore invited from the leading stone firms of the city and vicinity, and the stone was purchased in the open market from Hiero B. Herr & Co., the lowest bidders, at the rate of $6.22 per cord of 128 cubic feet.

On November 26, all the stone required had been put in place, amounting to—

	Cords.
In the north pier	521.68
In the south pier	400.47
Total	922.15

This work is at present in a very good condition, only a very slight settling of the stone being noticed.

On the 30th of October, 1888, a contract was entered into with Hiero B. Herr & Co. for extension of the south pier 150 linear feet. This work was commenced on May 1, 1889. The first crib was sunk June 3, the second on June 5. Each was 14 courses high and 75 feet in length. I beg leave to state that the hemlock timber used in these cribs is of the best quality ever seen in this locality.

The work under this contract was finished on the 30th of June, and completed the project of 1882 for an extension of the south pier 500 linear feet.

At the close of the fiscal year 3,640 linear feet of the north pier and 2,020 linear feet of the south pier had been completed. Over a large portion of this work, to wit, 800 feet of the north and 890 feet of the south pier, or in all 1,690 feet, the superstructure is in an extremely bad condition, and requires speedy renewal. Out of said 1,690 feet the westerly end of the south pier, 320 feet in length, consists of plank-beam revetment, built when the proposed depth in the harbor channel was only 13½ feet. The balance, 1,370 feet, is all crib-work. Over the latter portion new superstructure should be built, but the revetment could be best repaired by sheet-piling, constructed in front of the old work, with tie-rods to the old remaining anchor-piles, as done in repairing the similar structure directly opposite, on the north side of the river, in 1884. The cost of this work did not exceed $8 per running foot.

The cost of the proposed new superstructure and repair to revetment, based upon

contract prices for the work just completed and on cost of the work on repair of revetment on north pier, above referred to, would be:

1,370 linear feet of new superstructure, at $15.34 per linear foot	$21,015.80
320 linear feet sheet-piling, at $8	2,560.00
Total	23,575.80
Add 10 per cent. for superintendence, contingencies, etc	2,357.58
Total	25,933.38

The river channel is constantly filling up with sand, partly flowing down from the river above and partly washing in from the bar directly outside and south of the mouth. To remedy this, and secure a channel with sufficient and nearly permanent depth for the steadily increasing shipping at this port, it is required to dredge between the piers and extend the south pier 800 feet farther.

The cost of dredging to the full width between the piers is estimated as follows:

75,833 cubic yards (to secure a depth of 16 feet), at 25 cents	$18,970
Add 10 per cent. for contingencies, etc	1,897
Total	20,867

A depth of 16 feet has heretofore been considered as sufficient for this harbor, and the above estimate is made accordingly; but the dimensions of craft navigating Lake Michigan are gradually increasing, and large vessels carrying iron ore to the mills frequently draw more than 16 feet of water. I would, therefore, respectfully suggest the advisability of increasing the established depth to 18 feet, as has been done in other harbors on this lake. An estimate of cost to secure such depth has been made, and amounts to:

128,683 cubic yards, at 25 cents	$32,170
Add 10 per cent. for contingencies, etc	3,217
Total	35,387

The cost of extending the south pier 800 feet, as proposed, would be:

800 linear feet, at $60 per foot	$48,000
Add 10 per cent. for contingencies	4,800
Total	52,800

Summing up the amounts required for the necessary improvements to this harbor, will give the aggregate amount needed, as follows:

Repair of old work	$25,933.38
Extension of south pier	52,800.00
Dredging to a depth of 18 feet	35,387.00
Total	114,120.38

The shore-line north of and along the north pier has advanced a distance of 70 feet since July 19, 1888. As it has been officially claimed that the advance of this shore was more or less caused by the dumping of slag from the rolling mills, it is but fair to state that the later observations indicate that such is apparently not the case, the advance having continued uninterruptedly, and to about the same extent as before, long after the dumping of the slag had been stopped.

On July 18, 1888, the outer end of the north pier was severely damaged by the steamer *Manhattan*, a carrier of iron ore for the rolling mills, which, with a load of 1,900 tons of ore, ran into the pier in broad daylight. The damage was, however, repaired by and at the expense of the Rolling Mill Company in September following.

It has already been mentioned in this report about the dilapidated condition of portions of the piers. In this connection might be stated that certain artificial agencies exist that tend to hasten the natural progress of destruction and decay. A privy has been built by the Rolling Mill Company for the use of their men on the north pier, protruding over its edge towards the river, which in every respect must be considered a nuisance. One of the company's derricks has also had its braces attached for a long time to the timbers of the superstructure of said pier, thereby hastening the destruction of this already very old and weak structure.

The timbers of the north pier have been found burned in several places, presumably caused by cinders from the many locomotives operating on the Rolling Mill Company's grounds. This suggests the possibility of more serious destruction by fire if proper care is not taken to prevent it.

A map showing condition of the works on June 30, soundings on which estimate for dredging is based, and the proposed pier extension is shown, is herewith submitted

I am, captain, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The harbor of Calumet is at South Chicago, in the collection district of Chicago.

There is a light-house and a keeper's dwelling on the Government reservation near the shore end of the north pier. A beacon light is maintained at the extremity of the north pier to mark the entrance to the harbor.

Amount of revenue collected at the nearest port of entry (Chicago) during the last fiscal year, $4,966,198.72.

Calumet Harbor.	Number.	Tons.
Vessels arrived	478	469,483
Vessels cleared	449	315,849

Receipts and shipments by lake during the fiscal year ending June 30, 1889.

Articles.	Quantity.	Articles.	Quantity.
RECEIPTS.		Iron ore.....tons..	360,663
		Salt.....barrels..	338,875
Merchandise.....packages..	27,647		
Lumber.....feet..	30,759,000	SHIPMENTS.	
Shingles	5,100,000		
Posts.....number..	39,000	Grain.....bushels..	429,814
Railroad ties.....do....	29,600	Railroad iron.....tons..	300
Coal.....tons..	73,400	Railroad ties.....number..	7,500

JJ 3.

IMPROVEMENT OF THE ILLINOIS RIVER, ILLINOIS.

The ultimate object of this improvement is to furnish a through route of transportation from the southern end of Lake Michigan to the Mississippi River of sufficient capacity for its navigation by the largest class of Mississippi River steam-boats that can reach the mouth of the Illinois River.

The dimensions that have been adopted for the locks to meet this requirement are:

	Feet.
Length of chamber	350
Width of chamber	75
Depth at low water upon miter-sills	7

The low depth upon bars to be such as to give 7 feet available depth of navigation.

The conditions that have determined these dimensions heretofore have not changed since their adoption, as may be seen from the following facts:

The United States Government is now laboring to obtain throughout

the various reaches of the Mississippi the following depths of navigation at low water:

1. *Above mouth of Illinois River.*—Six feet ultimately. At present 3-foot depths are not unusual at low water, and depths of 4 feet or less are common.

2. *Between mouth of Illinois River and St. Louis.*—To maintain 6 feet depth at low water. At present 5 feet at low water is found at several points, and occasionally less than this depth has been reported by pilots.

3. *From St. Louis to the mouth of the Ohio.*—Eight feet ultimately. At present the low-water depth in the channel does not exceed at some points 4½ to 5 feet. Nearly $17,000,000 will be required in all to attain 8 feet in depth if the estimate proves correct.

4. *Between Cairo and the Head of the Passes.*—Ten feet ultimately. At present there is less than 8 feet of water at numerous places when the gauges read several feet above low water. The original estimate to secure 10 feet throughout this stretch was $33,000,000, of which over $13,000,000 have been appropriated, resulting in deepening the river throughout two reaches only. The largest steamer that navigates the Mississippi River above Vicksburg has a depth of hold not exceeding 9 feet. The largest steamer that reaches the mouth of the Illinois has a depth of hold of 6 feet 1 inch, and is 300 feet long. No record has been found of as great draught as 7 feet ever having been habitually carried by any steam-boat above St. Louis as far as to the mouth of the Illinois River, and Congress has not embarked in any improvement of that stream above the mouth of the Ohio River looking to an ultimate depth greater than 8 feet at low water.

This project now being executed is for the improvement of the lower section of this route, 135 miles in length, from the mouth of Copperas Creek to Mississippi River; another section of this route—88 miles in length, from the mouth of Copperas Creek to La Salle—has been improved by the State of Illinois, by the construction of two locks and dams, one at Copperas Creek and one at Henry.

Over this section the State still collects tolls; the United States not as yet having accepted the conditions imposed by the acts of cession of the Illinois legislature, which conditions seem to be subject to change, and recently to be of remarkable character. The act of the Illinois legislature of May 31, 1887, required as a condition of transfer that a channel be constructed by the United States from Lake Michigan to the Mississippi River, 7 feet in depth; while the act of June 4, 1889, requires an abandonment of the present project below La Salle, after it has been nearly completed, and the substitution of an entirely different plan of improvement, at vastly increased expense; which condition itself makes the proposed gift of the State of Illinois valueless to the United States. Moreover, the State requires as a condition of the transfer an expenditure on the part of the United States of an amount at least nine times the value of the property to be transferred, in excess of the cost of attaining the same end by carrying out the present project.

Surveys and estimates, based upon a low-water depth of 7 feet, for carrying the improvement over a third section, 64 miles in length, from La Salle to Joliet, over which the fall in the water surface is 100 feet, have been made and submitted to Congress, and may be found in the Report of the Chief of Engineers, U. S. A., for 1884, p. 1,958.

No appropriation has yet been made by Congress directing surveys or estimates for extending the project to Lake Michigan, 39 to 40 miles

further, but in the river and harbor act of August 11, 1888, there is a provision for a survey for a water-way of larger dimensions.

The present project involves the construction of two locks and dams, one at La Grange, 75 miles above the mouth of the Illinois, the other at Kampsville, about 30 miles above the mouth, and dredging the channel to 7 feet deep across bars. More than 2,000,000 cubic yards of dredging will be required.

CONDITION OF THE WORK JUNE 30, 1889.

The lock at La Grange is completed, and ready for use whenever the dam shall have been constructed. Material for the dam has been provided, which will be put in place as soon as the stage of water will admit, and the lock opened for navigation.

At Kampsville.—The coffer-dam is in place and the foundation of the lock has been constructed; 4,166.66 cubic yards of cut stone, including 2,882 cubic yards of cut stone delivered in 1887, and 2,300 cubic yards of backing, have been received at the lock-site and piled. No masonry has yet been laid; the dam and abutment also are still to be built.

But little of the dredging has been done beyond the removal of some of the worst bars to a depth of 4 feet at low-water.

During the fiscal year ending June 30, 1889, the following work has been done:

(*a*) *At La Grange Lock.*—Filling behind the head-wall of the land-wall has been placed, and a levee 450 feet in length has been constructed along the bank above the lock. The site of the dam has been dredged; portions of the coffer-dam have been removed, and the approaches to the lock partly excavated by dredging. In all, 31,141 cubic yards has been done of dredging, and 3,386 cubic yards of earth filling has been placed.

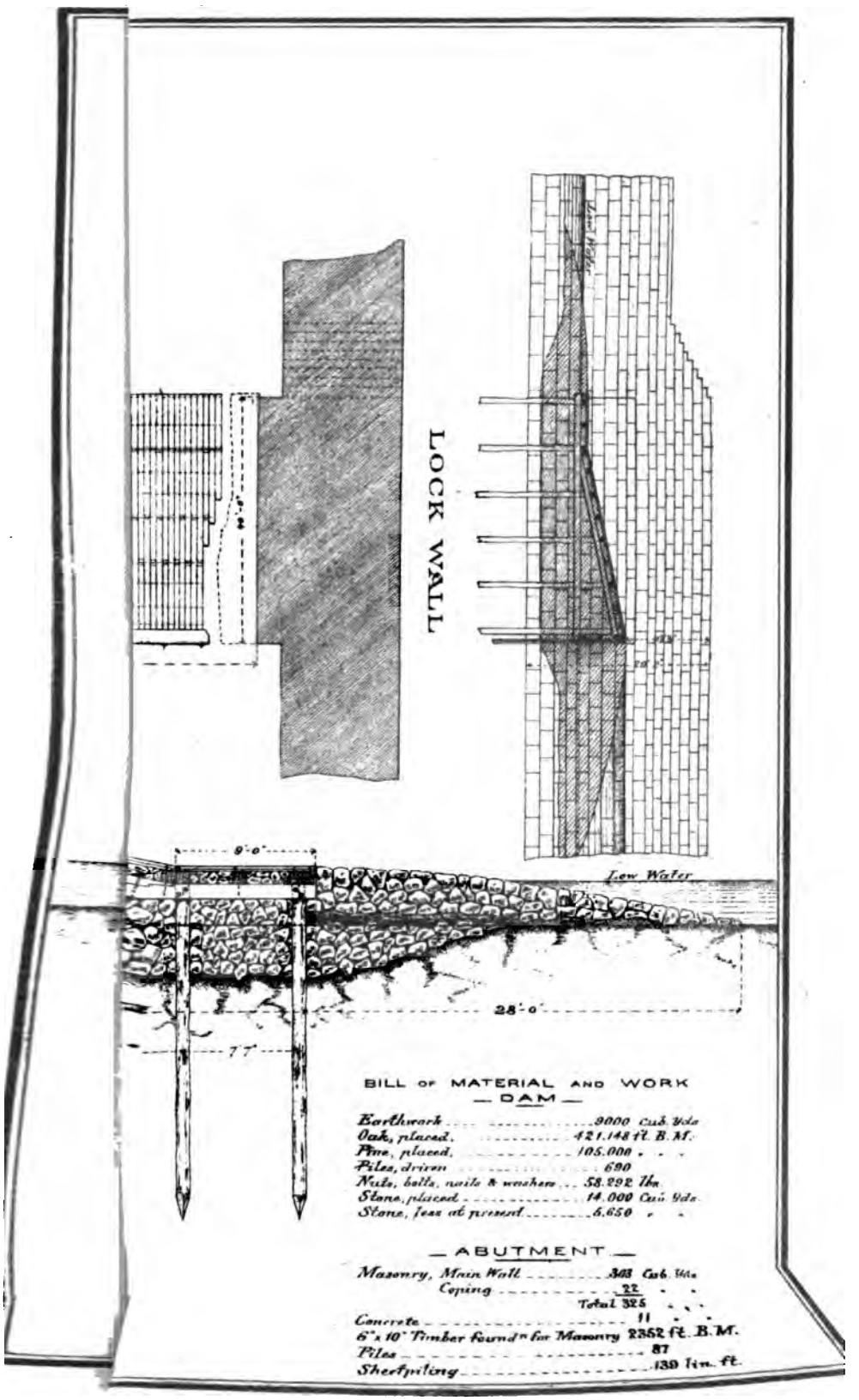
Arrangements have been made for all the piles, timber, and iron for the construction of the dam at this point, and 800 piles, 277,024 feet, B. M., lumber, and 57,506 pounds iron bolts, spikes, nuts, and washers have been delivered. The plant has been kept in repair, and boats and appliances provided for constructing the dam when the stage of water will allow.

(*b*) *At Kampsville Lock.*—A contract was entered into, with the approval of the Chief of Engineers, dated September 25, 1888, with Sanger & Moody, for the delivery of stone for this lock to the value of $90,000. Under this contract there has been delivered and properly piled at Kampsville 1,284.66 cubic yards of cut stone and 2,300 cubic yards of backing stone. The contractors have quarried and cut all of the stone required under their contract except about four hundred cubic yards, and expect to deliver the remainder by or before August 15, 1889. There will then remain to complete the masonry of the lock and abutment to dam only 1,228 cubic yards of dressed stone, no additional backing being required.

(*c*) *Snagging.*—One hundred and eighty-one snags were removed from the channel.

(*d*) *Survey of water-way between Lake Michigan and the Illinois River at La Salle.*—The river and harbor act of August 11, 1888, contained the following provision:

> And for the purpose of securing a continuous navigable water-way between Lake Michigan and the Mississippi River having capacity and facilities adequate for the passage of the largest Mississippi River steam-boats, and of naval vessels suitable for defense in time of war, the Secretary of War is authorized and directed to cause to be made the proper surveys, plans, and estimates for a channel improvement and



BILL OF MATERIAL AND WORK

— DAM —

Earthwork	9000 Cub. Yds
Oak, placed	421.148 ft. B. M.
Pine, placed	105.000 " "
Piles, driven	690
Nuts, bolts, nails & washers	58.292 lbs.
Stone, placed	14.000 Cub. Yds.
Stone, face at present	6.650 " "

— ABUTMENT —

Masonry, Main Wall	303 Cub. Yds.
Coping	22 " "
Total	325 " "
Concrete	11 " "
6" x 10" Timber found'n for Masonry	2352 ft. B.M.
Piles	87
Sheetpiling	139 lin. ft.

locks and dams in the beds of the Illinois and Desplaines rivers from La Salle to Lockport, so as to provide a navigable water-way not less than 160 feet wide, and not less than 14 feet deep, and to have surveyed and located a channel from Lockport to Lake Michigan at or near the city of Chicago, such channel to be suitable for the purposes aforesaid, the necessary expenses of such surveys, estimates, plans, and location to be paid out of the sum herein appropriated for the improvement of the Illinois River.

With reference to this provision it seems necessary to remark, in order that its inconsistencies may be rectified and its intent be made clear by subsequent legislation:

From what has been stated in this report with reference to the requirements of navigation that have been considered in planning the 7-foot navigation for the Lower Illinois River, it may be seen that the "facilities adequate for the passage of the largest Mississippi steamboats and naval vessels in time of war" that can reach the mouth of the Illinois River in ordinary seasons of navigation are not allowed to be considered in deciding upon the capacity of this water-way, but the depth is arbitrarily fixed at "not less than 160 feet wide and not less than 14 feet deep" over a *portion only* of the proposed water-way, viz, from Lockport to La Salle, while the conditions and requirements of navigation are still allowed to govern from Lockport across the Chicago divide to Lake Michigan, even as they govern throughout the rest of the line from La Salle to the Mississippi River.

A literal adherence to the act would require surveys, plans, and estimates for a channel "not less than 160 feet wide and not less than 14 feet deep" from Lockport to La Salle, while across the Chicago divide the dimensions would be adjusted to be "adequate for the passage of the largest-sized Mississippi River steam-boats" that, during ordinary seasons of navigation, could pass the channel below the mouth of the Illinois River, 6 feet deep at low water, and the channel of the Illinois River below La Salle, 7 feet deep at low water, when completed. The requirements of "not less than 14 feet in depth" between Lockport and La Salle is 60 per cent. in excess of the greatest depth of hold of any steam-boat navigating the Mississippi River above Vicksburg, and is two and one-third times the greatest depth of hold of any steam-boat navigating the Mississippi River above St. Louis.

As the intent of the act is not clearly apparent, it seems necessary to submit plans and estimates for the entire line under two heads. (1) As required by the stated purposes of the act, and the requirements of navigation, and (2) for a water-way "not less than 160 feet wide, and not less than 14 feet deep" without reference to the stated purpose of the act, or the requirements of navigation.

To pay the expenses of the surveys for the water-way between Lake Michigan and the Illinois River at La Salle, required by the act of August 11, 1888, an allotment of $25,000 from the appropriation for the Illinois River was approved by the Chief of Engineers.

A survey party was organized under the immediate direction of Civil Assistant L. L. Wheeler, who has had large experience in such work, which party took the field in October, 1888, and by the close of November had completed the superficial field work over all practicable lines between Joliet and Lake Michigan; it having been decided to accept the survey made in 1883 under direction of Maj. W. H. H. Benyaurd, Corps of Engineers, from Joliet to La Salle. Between Lake Michigan and Joliet the most practicable lines are, (1) by way of south branch of Chicago River and the Desplaines. (2) From the Calumet River at Blue Island *via* the old Calumet feeder north of Lane's Island, Sag Bridge, and the Desplaines Valley.

(3) The same as (2), except a détour from the old feeder route across to the south of Lane's Island to the Desplaines Valley at Sag Bridge. From Sag Bridge to La Salle all lines occupy the same field, *i. e.*, the Desplaines and Illinois valley.

Detailed surveys were also made during the fiscal year by this party in the vicinity of and below Joliet, and in the vicinity of Marseilles.

In addition to the superficial work of the survey an agreement was entered into with Josiah Stevens & Co., for making test borings to ascertain the nature of the substrata along the various possible routes between the Sag Bridge and Lake Michigan, and during the year 110 borings were completed, completing the work except some 8 or 10 borings along these lines.

These borings result in exhibiting the defective character of all previous determinations of the material to be encounted in any deep cut across the Chicago divide, the rock in place being materially less than heretofore reported, and the drift material and earth correspondingly greater in volume.

Borings are also required between Joliet and Marseilles, especially between the mouth of the Kankakee and Marseilles, and a special examination for high-water marks and levels throughout the portion of the Illinois valley under examination.

The maps of the survey are well advanced and in sufficient detail for the purpose of location and close estimates. Reference is made to the report of Assistant L. L. Wheeler herewith.

In connection with this survey discharge observations have been taken at four places on the Illinois River during the fiscal year, viz, at Ottawa, above the mouth of the Fox River; at Peru, below the mouth of the Fox and Vermillion rivers; at La Grange, and at Kampsville. It is desired to obtain a complete series of gaugings from extreme low water to the stage where the river bottoms are submerged or begin to be submerged.

The purposes of this survey do not require observations taken at extreme floods on the lower Illinois, but it is important to know what discharge stage begins to cause damage by flooding private lands and property, and what additions to the discharge of the Illinois may be made at different stages without damage to property, and to what extent, and for what length of time such additions may be beneficial to navigation.

Discharge observations should be continued through several years to be free from accidental causes of variation, and to be sufficiently reliable for the purposes intended.

As soon as the maps are plotted and the borings, which are necessarily slow, are completed and plotted on the profiles, estimates of cost of the proposed water-way may be begun. It is expected that the results of the survey may be in the hands of Congress before the close of the next session.

For details of work on the Illinois River during the past fiscal year see the reports herewith of Assistants W. M. Childs, in local charge of the improvement, and L. L. Wheeler, in charge of the survey, for a water-way between Lake Michigan and the Mississippi River.

PROPOSED APPLICATION OF FUNDS ON HAND JUNE 30, 1889.

It is proposed to apply the funds now on hand to construct the La Grange dam and open the lock to navigation, to complete the survey,

plans, and estimates for the water-way from Lake Michigan to La Salle, to continue the purchase of stone under contract for the Kampsville Lock, and to take care of public property.

PROPOSED APPLICATION OF FUNDS ASKED FOR FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

It is proposed to apply these funds to complete the Kampsville Lock and Dam, and to forward to completion the improvement of the lower Illinois River, as at present projected.

The route from Lake Michigan, near Chicago, to the Mississippi River, *via* the Illinois, is the most favorable route that exists, for a water route of liberal capacity, and at moderate cost, between the Mississippi River and the Great Lakes. The expenditure of an estimated amount of $412,000 will carry a channel from its mouth to La Salle, 100 miles from Lake Michigan, 7 feet deep at extreme low water, which is ample depth to accommodate the largest Mississippi steamers that reach the mouth of the Illinois, the proposed low-water depth being from 2 to 2½ feet greater than present low-water depths in the Mississippi River for 400 miles on either side of the mouth of the Illinois. The expenditure of an estimated amount of $3,500,000 will carry an equal depth to Joliet, within less than 40 miles from Lake Michigan, near Chicago. Surveys now in progress, being made for a channel of much greater capacity, will be in sufficient detail to allow plans and close estimates made for a channel of any reasonable capacity, that may be ordered by Congress, from Lake Michigan to the lower Illinois River at La Salle.

As the present low-water discharge of the Illinois River, 1,685 cubic feet per second, as measured at a stage 0.2 feet above low water at La Grange in 1887, is less than 8 per cent. greater than the discharge, 1,566 cubic feet per second, taken in 1880 when planning the present system of improvement, the impracticability of attaining the necessary depth of channel by dredging and wing-dams is as apparent now as then. To secure the same depth of navigation on the lower Illinois as will be given by the completion of the present project by any other means than by locks and dams, will certainly cost from eight to ten times the cost of the entire system below La Salle, and postpone indefinitely the use of this stretch of 225 miles of river at low water. The approved project is now completed within 20 per cent. of its total cost, including the State works at Henry and Copperas Creek, and should be completed at the earliest practicable moment, as the most economical, speedy, and certain way of meeting the requirements of navigation seeking the lower Illinois River.

Since the advantages of this route have been repeatedly brought to the attention of Congress during the past seventy years or more, further consideration here would be mere repetition, and attention will only be invited to the following named reports heretofore submitted to Congress within the past twenty years:

General J. H. Wilson, 1867, House Ex. Doc. No. 16, Fortieth Congress, first session.
Colonel Macomb, Corps of Engineers, Report of the Chief of Engineers, 1875, Vol. 2, page 525.
Maj. G. J. Lydecker, Reports of the Chief of Engineers, 1879, page 1572; 1880, page 1995.
Maj. W. H. H. Benyaurd, Report of the Chief of Engineers, 1884, page 1958.
Maj. Thomas H. Handbury, Report of the Chief of Engineers, 1887, page 2119.
Report of the Board of Engineers on Hennepin Canal, 1887, Report of the Chief of Engineers, 1887, page 2125.

Money statement.

July 1, 1888, amount available		$10,513.75
Received from sale of fuel to officer		33.75
Amount appropriated by act of August 11, 1888		200,000.00
		210,553.50
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$95,576.94	
July 1, 1889, outstanding liabilities	6,065.94	
July 1, 1889, amount covered by existing contracts	35,369.30	
		137,012.18
July 1, 1889, balance available		73,541.32

Amount (estimated) required for completion of existing project	412,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	412,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

The amount reported as available July 1, 1888—$10,227.35—is found to have been in error, being $292.40 too little.

REPORT OF MR. W. M. CHILDS, ASSISTANT ENGINEER.

VERSAILLES, BROWN CO., ILL., *July* 1, 1889.

SIR: I have the honor to submit the following report of operations upon the Illinois River for the year ending June 30, 1889:

From July to April the only work undertaken was to clear the channel of the Illinois River of snags and repair the plant.

From April to July the work has been dredging to open a channel to the lower entrance of the lock and receiving material for La Grange Dam and Kampsville Lock.

Snagging.—During September a small force, with steam-boat and derrick, pulled all the snags (181) out of the channel of the Illinois River from Peoria to the mouth at Grafton.

Dredging.—A shallow cut 28 feet wide has been dredged across the river for the base of the dam.

A bluff bank has been dredged along the shore above the lock to make a convenient place to unload the lumber for the dam.

One cut has been dredged through from the lower entrance of the lock to the channel, a distance of about 1,800 feet. In all, 31,142 cubic yards of material have been dredged.

La Grange Lock.—Banks have been thrown up closing the lock; engine and pumps have been placed in position to pump the lock dry for an examination of the valves.

The upper 14 feet of the lower gates and the upper 19 feet of the upper gates have been calked and painted.

All the iron work has been painted.

A small necessary house has been built back of the lock-keeper's house.

Two hundred cubic yards (approximately) of material have been wheeled and cast by the dredge onto the banks that have been thrown up to close the lock preparatory to pumping it out.

Kampsville Lock.—No work has been done at this lock; 1,284.66 cubic yards cut stone and about 2,300 cubic yards backing have been received on the contract of September 25, 1888.

La Grange Dam.—Two thousand eight hundred and fifty-nine cubic yards of filling have been put back of the upper end of the land wall. The material was hauled in wagons and wheel-scrapers from the upper end of the coffee-dam.

Abont 70 cubic yards of material have been wheeled back of the dam abutment on the west side of the river.

One hundred and eighty-five feet of the coffer-dam have been dredged out, to give space to build the dam.

The crib abutting the river wall has been built up with 10 by 10 timbers to a point 5 feet above low water.

Of the material necessary to build the dam the following has been received:

Oak	feet, B. M..	172,024
Pine	feet, B. M..	105,000
Oak piles (round)	number..	800
Iron	pounds..	57,506

Repairs to plant—Dredge No. 2 has had her iron crane wrecked and a new crane of oak built.

Ways were built, and Dredge No. 2, the office-boat, steamer *Hebe*, and a dump-scow have been hauled out and repaired. The steamer *Hebe*, having an iron hull, was scraped and painted.

The dredges and steam-boats have been thoroughly painted.

The steamer *Hebe* has had a new canvas roof, floor, and iron rudder.

Two new pile drivers have been built and one repaired.

Two flats 16 by 30 feet have been rebuilt, gunwales raised, and new decks laid.

Last fall an ice-house was built of second-hand plank and timber, and 140 tons of ice put up.

Very respectfully, your obedient servant,

W. M. CHILDS,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers. U. S. A.

REPORT OF MR. L. L. WHEELER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., June 30, 1889.

CAPTAIN: I have the honor to submit the following report of progress of survey for water-way between Lake Michigan and Mississippi River, required by river and harbor act of August 11, 1888.

Commencing at Lake Michigan, there are two routes by which a ship-canal might reach the valley of the Desplaines River; the one leaving the lake at Chicago and reaching the Desplaines River at Summit; the other leaving the lake at South Chicago and reaching the Desplaines River at Sag Bridge. Below Sag Bridge but one route can be followed—that of the valleys of the Desplaines and Illinois rivers.

Upon commencing the work it was decided to make a complete survey of that portion of the proposed routes lying between Lake Michigan and Joliet, and to use maps of the portion between Joliet and La Salle, prepared under direction of Maj. W. H. H. Benyaurd, Corps of Engineers, U. S. Army., in 1883, making special surveys where necessary.

A field party was organized and took the field October 1, and by November 30 had made the necessary surveys between Lake Michigan and Joliet. The survey consisted of chained transit lines, duplicate lines of levels, and stadia elevations over the entire width of the valleys followed. The party was disbanded November 30, and the reduction and plotting of notes commenced.

It was found on plotting the notes that sufficient details had not been obtained in that portion lying between Lockport and Joliet. It was also found that the maps of vicinities of Joliet, Treat's Island and Marseilles did not give sufficient details to base estimates on. A small party was therefore organized and put into the field April 8, and on May 10 completed the desired surveys.

Between Lake Michigan and Lockport all possible routes are entirely in excavation, the material to be excavated varying from soft river and lake deposit at the northern end of this portion to limestone rock at the southern end. It was therefore necessary to determine definitely the character of the material to be excavated, in order to make reliable estimates of the cost of such excavation. Bids were therefore solicited for putting down test borings along the proposed routes, and a contract made with Josiah Stevens & Co., of Elgin, Ill., for doing this work. Work was commenced at junction Little Calumet River and Stony Creek December 19, and by April 5, 64 borings had been put down between that point and Sag Bridge. These borings were about one-half mile apart, and were put down 18 feet below low water in Lake Michigan plus an allowance of one-tenth foot per mile for slope. If rock was met at a higher elevation than this the boring was stopped when it was certain that rock in place had been reached.

These borings showed two favorable routes between Blue Island and Sag Bridge, one following the old Calumet Feeder north of Lane's Island, the other passing south of Lane's Island and joining the feeder route 5 miles east of Sag Bridge. They also

showed that previous reports had greatly exaggerated the difficulties Instead of 17 miles of continuous rock excavation, as had been prev be necessary along the feeder route, only about 2 miles of rock cutti

Borings along the route, starting from Chicago, were commenced this date 46 borings have been completed, the depth and allowance the same as on the other route. As was the case on that route, much vation is necessary than had previously been reported.

In putting down these test borings both steam and hand tools have every means taken by the contractors to expedite the work; but th been so difficult to penetrate that progress has been slow. At presen the Desplaines River has made it necessary to construct flat-boats t work.

The notes of the survey have been platted on 8 maps drawn to th equals 400 feet, and 3 maps drawn to the scale 1 inch equals 200 maps all elevations determined have been printed and contours dra them. Profiles of proposed routes, sections of borings and their loca topographical features as are necessary to a clear understanding of th proposed routes are shown on these maps. The preparation of these n vanced. The proposed routes between Grand Calumet River and Sa been laid down on them and the amount of earth and rock excavat first, on the assumption of a level cut 14 feet deep below low water i gan, and, second, on the assumption of a level cut 8 feet deep below th

Very respectfully, your obedient servant,

L. L. W
Assist

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The following comparative tables are taken from the annual repor chants' Exchange, St. Louis, Mo., for the year 1888:

Arrivals and departures of steam-boats and barges, 1888, at St. Lou

ARRIVALS.

Months.	Upper Mississippi.	Lower Mississippi.	Illinois.	Missouri.	Ohio.	Cumberland and Tennessee.	Total steamers.	Barges, coal-boats and scows.	Fr rec
1888.									T
January									
February	3	20				5	28	23	1
March	55	66	19	10	11	17	178	121	6
April	76	71	20	12	15	9	203	159	9
May	96	74	16	14	17	9	226	169	7
June	116	62	20	17	13	9	237	153	7
July	126	66	11	32	11	9	255	109	7
August	122	67	26	30	12	9	266	93	5
September	103	66	16	26	9	5	225	117	3
October	90	69	13	19	7	4	202	128	3
November.	56	61	11	13	12	7	160	106	4
December.	29	45	1	16	2	6	99	75	1
Total	872	667	153	189	109	89	2,079	1,244	59

Upper Mississippi, 130,855 tons by raft.

Arrivals and departures of steam boats and barges, 1888, at St, Louis, Mo.—Continued.

DEPARTURES.

Months.	Upper Mississippi.	Lower Mississippi.	Illinois.	Missouri.	Ohio.	Tennessee.	Red and Ouachita.	Total steamers.	Tons shipped.
1888.									
January									
February	1	20		2	1	5		29	31, 255
March	55	58	16	6	18	11	2	166	52, 330
April	73	73	21	12	13	9		201	70, 965
May	95	76	15	15	15	10		226	59, 550
June	118	64	17	16	10	9		234	42, 445
July	127	67	12	32	10	8		256	37, 130
August	128	67	24	31	10	10		270	68, 805
September	92	77	15	26	8	7		225	49, 710
October	86	67	9	26	6	5		199	31, 350
November	58	65	11	11	13	8		166	27, 735
December	37	52	3	3	4	5		104	38, 840
Total	870	686	143	180	108	87	2	2, 076	510, 115

River tonnage by months.

RECEIPTS BY RIVER IN TONS, 1888, AT ST. LOUIS, MO.

Months.	Upper Mississippi.	Lower Mississippi.	Illinois.	Missouri.	Ohio.	Cumberland and Tennessee.	By raft.	Total tons.
January								
February	50	12, 205				1, 240		13, 495
March	6, 255	25, 675	19, 075	1, 200	12, 540	3, 065	2, 185	69, 995
April	8, 285	24, 335	32, 195	1, 420	25, 700	1, 735	12, 155	105, 825
May	11, 500	23, 120	10, 115	1, 970	30, 010	3, 075	8, 635	88, 425
June	13, 130	17, 900	9, 210	1, 475	32, 050	3, 745	21, 395	98, 905
July	19, 115	36, 295	3, 635	3, 065	8, 085	2, 710	19, 060	92, 865
August	18, 080	21, 755	4, 445	3, 360	7, 360	3, 335	26, 400	84, 735
September	14, 640	16, 265	2, 495	2, 990	165	1, 355	16, 810	54, 720
October	10, 200	21, 690	2, 000	1, 955	70	975	18, 715	55, 605
November	9, 440	24, 555	2, 090	855	3, 650	2, 340	5, 300	48, 230
December	4, 245	9, 120	300	645		1, 500	200	16, 010
Total	114, 940	232, 915	85, 560	19, 835	119, 630	25, 075	130, 855	733, 810
1887	132, 400	268, 735	78, 560	27, 700	121, 670	23, 815	213, 165	866, 045

TONS OF FREIGHT SHIPPED BY RIVER, 1888, AT ST. LOUIS, MO.

Months.	Lower Mississippi.	Upper Mississippi.	Illinois River.	Missouri River.	Ohio River.	Tennessee. River.	Red and Ouachita rivers.	Total tons.
January								
February	29, 545					1, 710		31, 255
March	43, 800	3, 835		640	1, 080	1, 025	1, 950	52, 330
April	54, 685	8, 255	900	330	4, 175	2, 620		70, 965
May	38, 970	12, 130	970	970	3, 615	2, 895		59, 550
June	29, 505	6, 795	1, 400	905	1, 650	2, 190		42, 445
July	28, 705	5, 235	75	345	1, 200	1, 570		37, 130
August	56, 480	5, 925	1, 420	1, 035	2, 550	1, 395		68, 805
September	41, 170	3, 465	950	755	2, 450	920		49, 710
October	26, 190	2, 080	570	600	800	1, 110		31, 350
November	22, 605	1, 855	300	280	1, 175	1, 520		27, 735
December	36, 790	740		60	300	950		38, 840
Total	408, 445	50, 315	6, 585	5, 920	18, 995	17, 905	1, 950	510, 115

Statement showing movement in flour and grain by river for 1888.

RECEIPTS.

By—	Flour.	Wheat.	Corn.	Oats.	Rye.	Barley.
	Barrels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Upper Mississippi River boats	66,701	326,875	73,900	313,880	6,077	429
Lower Mississippi River boats	20,103	997,661	3,235	5,580	709	3,661
Illinois River boats	1,107	532,013	149,619	15,585	1,177	43
Missouri River boats	2,659	370,210	76,825	2,450	459	.....
Total	90,570	2,226,759	303,579	337,495	8,422	3,533

SHIPMENTS.

Upper Mississippi River boats	1,575	.....	453	5,310	.....	.....
Illinois River boats	1,158	.....	.....	.....	.....	.....
Missouri River boats	167	.....	1,950	725	468	.....
Total	2,900	.....	2,403	6,035	468	.....

MEMORANDUM "CHICAGO DRAINAGE AND WATER-WAY LAWS."

Whatever may be the necessities of the city of Chicago for local drainage, or whatever may be the merits of the scheme for draining into the Illinois River as a sanitary measure, concern only the people of the city of Chicago and the inhabitants of the Illinois River Valley; but since this project has been brought forward by the Illinois legislature as a work for the benefit of the navigation intrusted to this office, it is necessary to notice it. It is noticed, not for the purpose of commenting upon it as a sanitary necessity for the relief of the densely populated area in the vicinity of the city of Chicago, but to present a few remarks in relation to the measure regarded as a work for the benefit of the navigation of the Illinois River, to be substituted for the plan now under execution, or to form a part of its continuation.

In embarking upon any costly scheme for river improvement, after the physical features of the stream have been well determined by surveys and observations, Congress has been usually informed upon many other matters connected with the proposed works, among others the following:

1. What is the character and requirement of the navigation that must be subserved, as to draught, width of beam, and speed; *i. e.*, what depth, width, and velocity of current or slope must the improved water-way have?

2. What is the best and most economical means of meeting these requirements?

3. How far, without increased cost to the public, may purely local necessities be subserved, without material injury to the requirements of navigation?

4. To what extent is it necessary to take private property for the public purpose of making the necessary improvement? And in this case it is also necessary to consider—

5. To what extent will the United States become responsible for damage to private property, by modifying or allowing modification in works for national purposes to subserve purely local ends or objects, or by entering jointly with localities in constructing channels for navigation and local drainage?

The physicial peculiarities of the Illinois River and the Chicago divide have been so often reported to Congress that it is unnecessary here to again describe them.

In the act of August 11, 1888, the requirements of any channel that may be constructed *via* the Illinois River between Lake Michigan and the Mississippi River are stated to be—

Facilities adequate for the passage of the largest Mississippi River steam-boats, and of naval vessels suitable for defense, in time of war.

As all naval vessels, as well as steam-boats, which at any time will patrol the Western rivers, will be built to suit the conditions of navigation as they exist in these streams, it is unnecessary to say that the same conditions govern both classes as far as draught and general dimensions are concerned. A channel which will pass the largest Mississippi River steam-boat that can reach the mouth of the Illinois during ordinary seasons of navigation will pass, in all probability, any naval vessel that will ever be found in the vicinity of the Upper Mississippi River.

Under these conditions, without any attempt at this time to answer the above questions fully or in detail, a few remarks are now made simply to indicate that there may be points in connection with this subject that are precipitated by the resolutions of the legislature of the State of Illinois requesting a stoppage of work under the project that is now nearly completed, and the adoption of another plan by the General Government, that should be thoroughly investigated by competent persons, acting under the direction of Congress, in order that the interests of the United States and the public in this proposed line of communication may be properly guarded, and the United States be not involved in expense or become responsible for damages by flowage or otherwise beyond what the public interests of navigation demand and make necessary, except after full understanding of the circumstances and requirements of the case, both local and national.

The annual reports of the Chief of Engineers, U. S. A., and of the Mississippi River Commission, as well as the special reports upon the Illinois River hitherto published by Congress, give full information upon the navigation and requirements for navigation of the various Western rivers, and especially of the Mississippi River, the most important of all. These conditions and requirements, as they then existed, were considered when the depth required in the Illinois River was fixed at 7 feet at low water upon the miter-sills of locks and upon bars, and the dimensions of the locks fixed at 350 feet in length and 75 feet in width of lock-chambers. The conditions which determined these dimensions have not changed since the present project was adopted, as may be seen from the following facts taken mainly from the official reports of the Chief of Engineers, U. S. A., made during the past two years.

Under specific appropriations for river and harbor improvements the United States Government is now laboring to secure throughout various divisions of the Mississippi River the following depths at low water:

1. *Above the mouth of the Illinois River.*—Six feet ultimately. At present there does not exceed, at low water, 4 feet at numerous points. At other points there does not exceed 3 feet depth.

2. *Between the mouth of the Illinois and St. Louis.*—To maintain 6 feet depth. Pilots navigating the Mississippi report that the low-water depths in 1886 and 1887 were less than 5 feet at several points.

3. *From St. Louis to the mouth of the Ohio River.*—Eight feet ultimately. At present the low-water depth in the channel does not exceed at some points 4½ to 5 feet. Nearly $17,000,000 will be required in all to attain 8 feet in depth, if the estimates prove correct.

4. *Between Cairo and the Head of the Passes.*—Ten feet ultimately. At present there is less than 8 feet depth at numerous points when the

gauge reads nearly that much above low water, the bottom of the Mississippi being unstable. The Mississippi River Commission's original estimate to secure 10 feet low-water depth from Cairo to the Head of the Passes was $33,000,000. Since that estimate was made more than $13,000,000 have been appropriated, resulting in deepening two out of six bad reaches, but not in completing the improvement at either of them, and it is not known whether the Commission now adheres to its original estimate.

The largest steamers that navigate the Mississippi River above Vicksburg have a depth of hold not exceeding 9 feet. The largest steamer that reaches the mouth of the Illinois River has a depth of hold of only 6 feet 1 inch, and is 300 feet in length.

No record has been found of as great a draught as 7 feet ever having been habitually carried by any steam-boat above St. Louis as far as the mouth of the Illinois River, and Congress has not embarked in any improvement of that river in the vicinity of the Illinois, or above the mouth of the Ohio River, looking to an ultimate depth greater than 8 feet.

It is not evident that it has ever been the custom of Congress to appropriate money to facilitate through navigation by providing, at increased cost, for greater width and depth of channels than required by the class of vessels that can reach the locus of the proposed improvement through its connecting links, and from the published dimensions of vessels navigating the Western rivers, which vessels are built presumably best to meet their requirements and the circumstances of the navigation of those streams, it can be easily determined what depth and width of channel is sufficient for their requirements. The pressing present necessities of river navigation throughout the Union should very properly first be met before unnecessary facilities are provided for a special locality.

The city of Chicago, for better drainage, as formulated by the engineers in the employ of the city, requires a channel from 18 to 22 feet in depth, 160 feet wide, with a slope and current sufficient to give a discharge of from 300,000 to 600,000 cubic feet per minute. The present discharge of the Illinois River is sufficient for the supply of the channel for navigation, under the plan now in course of construction, and little or no land will be flooded by the necessary works of navigation; but an increased discharge, of 300,000 to 600,000 cubic feet per minute, will introduce into a system of navigation by locks and dams, and into a restricted canal and river (Desplains), which system must be adopted from Chicago to La Salle (100 miles) a current which is to a greater or less degree injurious to navigation; will maintain constantly at much above the flood stage one of the main tributaries of the Illinois River (Desplains), and make damaging floods possible upon the superposition of ordinary summer freshets in any one or more of the other tributaries of the Illinois at times when floods would not otherwise occur; will make much more costly the long rock cut through the Chicago divide, due to increased depth required to give the necessary slope and discharge, and much more costly the works for establishing the navigation between Lockport and La Salle (where there is a descent of more than 140 feet in the river surface), to take care of the surface discharge, and to guard against damage by floods; will maintain the Lower Illinois River several feet (variously estimated at from 5 to 10 feet) above its normal level, and cause to be flooded, at times when it otherwise would not be flooded, from 100,000 to 300,000 acres of land in the Illinois Valley.

While necessarily employing locks and dams for navigation from Lockport to La Salle, this discharge will deprive an otherwise slack-water system of all the advantages of that system, while retaining its obstructive features, and while increasing the cost of the work will cause damage by overflow of lands that the requirements of the public for a navigable channel between Lake Michigan and the Mississippi River by no means make necessary, and will result in benefiting navigation on the Illinois River, if it can be said to benefit it at all, only in the substitution upon the Lower Illinois, at vastly increased expense, of 7 feet open-river navigation (with a current opposing up stream navigation for 225 miles) for 7 feet slackwater navigation, offering equal facilities for both up-stream and down-stream navigation, with four locks and dams obstructing navigation to the extent of the time consumed by lockages thereat, which latter system is already nearly completed and paid for.

The resolution of the Illinois legislature, reciting the increase since 1880 in the discharge of the Illinois and Michigan Canal into the Illinois River, and partly on that account demanding stoppage of work on the locks and dams at La Grange and Kampsville and the improvement of the Lower Illinois River by dredging and the adoption of another plan of improvement, is misleading as far as it causes it to be inferred that the discharge of the Illinois River has been increased 50 per cent. since 1880, and that it is now sufficient to maintain an open-river navigation by dredging through bars in its channel at reasonable expense, or at less expense than the completion of the locks and dams at La Grange and Kampsville.

The present discharge of the Illinois and Michigan Canal, as measured under my direction, is about 700 cubic feet per second; a few cubic feet, more or less. An increase, as shown below, of 119 cubic feet per second since 1880, if the entire increase in the measured low-water discharge of the Illinois River may be attributed to it. The discharge of the Illinois River was measured 2 feet above the extreme low-water stage at La Grange, 70 miles above its mouth, in 1887, and shows the low-water discharge to be 1,685 cubic feet per second. The same stage was reached in 1886 and 1888. This discharge is insufficient to maintain a channel of sufficient width and depth in the Illinois River by dredging at reasonable cost, and it shows decisively that the present low-water discharge of the Illinois River does not greatly exceed the low-water discharge taken when planning the present system of improvement in 1880, viz, 1,566 cubic feet per second, the increase being less than 8 per cent. instead of 50 per cent., as left to be inferred by the joint resolution of the Illinois legislature.

To secure a channel of equal depth as that proposed by the locks and dams on the Illinois River, and of much less width and capacity, even if the discharge be sufficient to fill and maintain the dredged cuts through bars without a costly system of wing-dams, which is doubtful, would require not less, and probably more, than 6,000,000 cubic yards of dredging, which would employ the two dredges now owned by the United States at least twenty years to execute.

To obtain the same result as will be attained by the completion of the locks and dams by giving an increased discharge to the Illinois River by increasing the dimensions and slope of the cut beyond what is necessary for navigation across the Chicago divide would increase the cost of that cut beyond what is necessary for navigation at least three times the entire cost of the Lower Illinois River improvement, to which should be added the cost of those works, thus rendered unnec-

essary after they have been nearly completed, and the increased cost of safely conducting this water down the slope from Lockport to La Salle, and also the cost of land damages by resulting flooding.

The completion of the locks and dams in the Illinois River therefore offers an effectual, and the most speedy and economical, solution of the question of the improvement of the low-water navigation of the Illinois River. When any better, or even an equivalent, system shall have been substituted without increased cost to the United States as an incident or result of works designed for meeting purely local necessities for drainage and sewerage not at all connected with interests of navigation, it will then be time to remove these works as no longer necessary. At present no project of this kind has been definitely adopted, or will probably be executed within the next ten years if adopted, the amount of work being so great; and abandonment of the work on the Illinois River now means simply an indefinite postponement of that needed improvement. Its completion is a matter of less than 20 per cent. of its total cost, including the works at Henry and Copperas Creek, and can be done in one working season if means are made available. If now abandoned, 80 per cent. of its cost will be lost, without any return whatever to the public for its expenditure, as far as the two lower locks and dams are concerned.

The laws and resolutions passed by the Illinois legislature, and submitted herewith, simply emphasize the importance of a thorough investigation, under direction of Congress, of all the circumstances and requirements of the navigation of the Illinois River, and of the present status and requirements of the navigation of the western rivers connected therewith, in order that the interests of the United States may be properly guarded in the adoption of any plan for the completion or extension of the water way via the Illinois River from the Mississippi River to Lake Michigan.

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W. L. MARSHALL,
Captain of Engineers.

CHICAGO DRAINAGE AND WATER-WAY LAWS.

[Published by the Citizens' Association of Chicago.—From the Chicago Legal News edition of the laws of 1889.]

To create sanitary districts and to remove obstructions in the Desplaines and Illinois rivers, etc.

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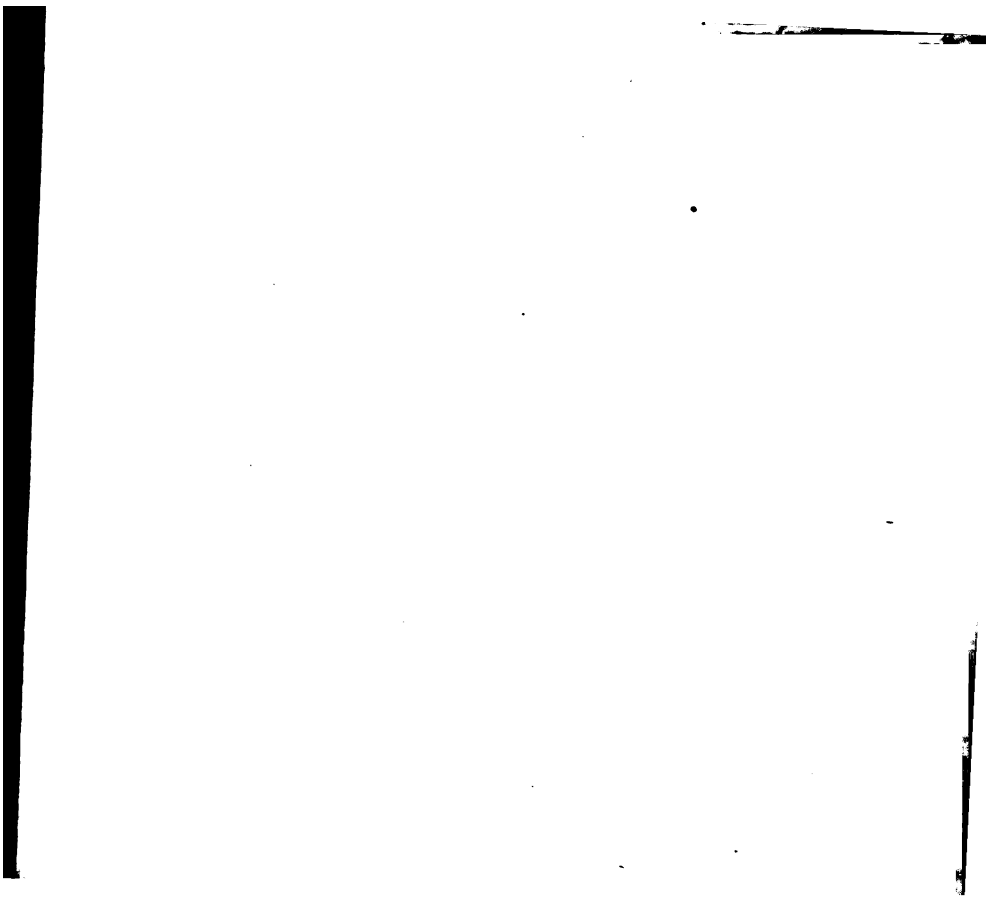
AN ACT to create sanitary districts and to remove obstructions in the Desplaines and Illinois rivers, approved May 29, 1889; in force July 1, 1889.

186. INCORPORATING SANITARY DISTRICT—QUESTION, HOW SUBMITTED—COMMISSIONERS.] § 1. *Be it enacted* by the people of the State of Illinois, represented in the general

DES PLAINES
EVANSTON
LAKE MICHIGAN
Norwood Park
Jefferson
Irving Park
MAYWOOD
Oak Park
Wheaton
RIVERSIDE
Western Springs
Hinsdale
La Grange
Summit
Downer's Grove
LAKE
Willow Springs
Sag Bridge
Lemont
Pullman
Kensington
Romeo
LOCKPORT
JOLIET
CHICAGO DIVIDE
LAKE MICHIGAN TO LAKE JOLIET.
DES PLAINES AND MUD LAKE.
SAG AND CALUMET ROUTE.
SAG BRIDGE TO LAKE JOLIET.
A. Zeese & Co., Engrs., Chi.



assembly, That whenever any area of contiguous territory within the limits of a single county shall contain two or more incorporated cities, towns, or villages, and shall be so situated that the maintenance of a common outlet for the drainage thereof will conduce to the preservation of the public health, the same may be incorporated as a sanitary district under this act, in the manner following: Any 5,000 legal voters resident within the limits of such proposed sanitary district may petition the county judge of the county in which they reside to cause the question to be submitted to the legal voters of such proposed district whether they will organize as a sanitary district under this act. Such petition shall be addressed to the county judge, and shall contain a definite description of the territory intended to be embraced in such district, and the name of such proposed sanitary district: *Provided, however*, that no territory shall be included in any municipal corporation formed hereunder which is not situated within the limits of a city, incorporated town, or village, or within three miles thereof, and no territory shall be included within more than one sanitary district under this act. Upon the filing of such petition in the office of the county clerk of the county in which such territory is situated it shall be the duty of the county judge to call to his assistance two judges of the circuit court, and such judges shall constitute a board of commissioners, which shall have power and authority to consider the boundaries of any such proposed sanitary district, whether the same shall be described in such petition or otherwise. Notice shall be given by such county judge of the time and place where such commissioners will meet, by a publication inserted in one or more daily papers published in such county, at least twenty days prior to such meeting. At such meeting the county judge shall preside, and all persons in such proposed sanitary district shall have an opportunity to be heard touching the location and boundary of such proposed district, and make suggestions regarding the same, and such commissioners, after hearing statements, evidence, and suggestions, shall fix and determine the limits and boundaries of such proposed district, and for that purpose and to that extent may alter and amend such petition. After such determination by said commissioners, or a majority of them, the county judge shall submit to the legal voters of the proposed sanitary district the question of the organization and establishment of the proposed sanitary district, as determined by said commissioners, at an election to be held on the first Tuesday after the first Monday in November thence next ensuing. Notice whereof shall be given by said commissioners, at least twenty days prior thereto, by publication in one or more daily papers published within such proposed sanitary district, such notice to specify briefly the purpose of such election, with a description of such proposed district. Each legal voter resident within such proposed sanitary district shall have the right to cast a ballot at such election, with the words thereon, "For Sanitary District," or "Against Sanitary District." The ballots so cast shall be received, returned, and canvassed in the same manner and by the same officers as is provided by law in the case of ballots cast for county officers. The county judge shall cause a statement of the result of such election to be spread upon the records of the county court. If a majority of the votes cast upon the question of the incorporation of the proposed sanitary district shall be in favor of the proposed sanitary district, such proposed district shall thenceforth be deemed an organized sanitary district under this act.

187. JUDICIAL NOTICE OF DISTRICT—ORGANIZATION—ELECTION—COUNTY JUDGE. § 2. All courts in this State shall take judicial notice of the existence of all sanitary districts organized under this act. Upon the organization of any sanitary district under this act the county judge shall call an election to elect officers and cause notice thereof to be posted or published, and perform all other acts in reference to such election in like manner as nearly as may be, as he is required to perform in reference to the election of officers in newly organized cities under the provisions of an act entitled "An act to provide for the incorporation of cities and villages," approved April 10, 1872.

188. TRUSTEES—ELECTION AND TERMS OF.] § 3. In each sanitary district organized under this act, there shall be elected nine trustees who shall hold their offices for five years, and until their successors are elected and qualified, except the term of office of the first trustees elected, shall be until five years after the first Monday in December after their election. The election of trustees, after the first, shall be on the Tuesday next after the first Monday in November in every fifth year. In all elections for trustees each qualified voter may vote for as many candidates as there are trustees to be elected, or he may distribute his vote among not less than five ninths of the candidates to be elected, giving to each of the candidates among whom he distributes the same, the same number of votes or fractional parts of votes. The trustees shall choose one of their number president, and such sanitary district shall, from the time of the first election held by it under this act, be construed in law and equity a body corporate and politic, and by the name and style of the sanitary district of ————, and by such name and style may sue and be sued, contract and be contracted with, acquire and hold real estate and personal property necessary for corporate purposes, and adopt a common seal and alter the same at pleasure.

169. TRUSTEES CONSTITUTE A BOARD—DUTIES AND POWERS OF.] § 4. The trustees elected in pursuance of the foregoing provisions of this act shall constitute a board of trustees for the district by which they are elected, which board of trustees is hereby declared to be the corporate authorities of such sanitary district, and shall exercise all the powers and manage and control all the affairs and property of such district. Said board of trustees shall have the right to elect a clerk, treasurer, chief engineer, and attorney for such municipality, who shall hold their respective offices during the pleasure of the board, and who shall give such bond as may be required by said board. Said board may prescribe the duties and fix the compensation of all the officers and employés of said sanitary district: *Provided, however*, that the salary of the president of said board of trustees shall in no case exceed the sum of four thousand dollars per annum; and the salary of the other members of said board shall not exceed three thousand dollars per annum. *And provided further*, That the amount received by any attorney shall not exceed the sum of five thousand dollars ($5,000) per annum. Said board of trustees shall have full power to pass all necessary ordinances, rules, and regulations for the proper management and conduct of the business of said board of trustees and of said corporation, and for carrying into effect the objects for which such sanitary district is formed.

190. ORDINANCES MAKING APPROPRIATION—PUBLICATION OF.] § 5. All ordinances making any appropriations shall, within one month after they are passed, be published at least once in a newspaper published in such district, or if no such newspaper of general circulation is published therein, by posting copies of the same in three public places in the district; and no such ordinance shall take effect until ten days after it is so published, and all other ordinances, orders, and resolutions shall take effect from and after their passage unless otherwise provided therein.

191. ORDINANCES AND RESOLUTIONS—EVIDENCE.] § 6. All ordinances, orders, and resolutions, and the date of publication thereof, may be proven by the certificate of the clerk, under the seal of the corporation, and when printed in book or pamphlet form and purporting to be published by the board of trustees, and such book or pamphlet shall be received as evidence of the passage and legal publication of such ordinances, orders, and resolution, as of the dates mentioned in such book, or pamphlet, in all courts and places without further proof.

192. BOARD OF TRUSTEES—POWERS OF.] § 7. The board of trustees of any sanitary district organized under this act shall have power to provide for the drainage of such district by laying out, establishing, constructing, and maintaining one or more main channels, drains, ditches, and outlets for carrying off and disposing of the drainage (including the sewage) of such district, together with such adjuncts and additions thereto as may be necessary or proper to cause such channels or outlets to accomplish the end for which they are designed in a satisfactory manner; also to make and establish docks adjacent to any navigable channel made under the provisions hereof for drainage purposes, and to lease, manage, and control such docks, and also to control and dispose of any water-power which may be incidentally created in the construction and use of said channels or outlets, but in no case shall said board have any power to control water after it passes beyond its channel, waterways, races, or structures into a river, or natural water-way, or channel, or water-power, or docks situated on such river or natural water-way or channel: *Provided, however*, nothing in this act shall be construed to abridge or prevent the State from hereafter requiring a portion of the funds derived from such water-power, dockage, or wharfage to be paid into the State Treasury to be used for State purposes. Such channels or outlets may extend outside of the territory included within such sanitary district, and the rights and powers of said board of trustees over the portion of such channel or outlet lying outside of such district shall be the same as those vested in said board over that portion of such channels or outlets within the said district.

193. MAY PURCHASE AND SELL REAL ESTATE, ETC.] § 8. Such sanitary district may acquire by purchase, condemnation, or otherwise any and all real and personal property, right of way and privilege, either within or without its corporate limits, that may be required for its corporate purposes: *Provided*, all moneys for the purchase and condemnation of any property shall be paid before possession is taken, or any work done on the premises damaged by the construction of such channel or outlet, and in case of an appeal from the county court taken by either party whereby the amount of damages is not finally determined, the amount of judgment in such court shall be deposited at some bank, to be designated by the judge thereof, subject to the payment of such damages on orders signed by such county judge, whenever the amount of damages is finally determined; and when not longer required for such purposes to sell, convey, vacate, and release the same, subject to the reservation contained in section 7, relating to water-powers and docks.

194. MAY BORROW MONEY—LIMITATION.] § 9. The corporation may borrow money for corporate purposes and may issue bonds therefor, but shall not become indebted, in any manner or for any purpose, to an amount in the aggregate to exceed five per centum on the valuation of taxable property therein, to be ascertained by

the last assessment for State and county taxes previous to the incurring of such indebtedness: *Provided, however*, That said five per centum shall not exceed the sum of fifteen million dollars ($15,000,000).

195. TO PROVIDE FOR DIRECT ANNUAL TAX—NETEARNINGS.] § 10. At the time or before incurring any indebtedness, the board of trustees shall provide for the collection of a direct annual tax sufficient to pay the interest on such debt as it falls due, and also to pay and discharge the principal thereof as the same shall fall due, and at least within twenty years from the time of contracting the same: *Provided*, that the net earnings from water-power and docks may be appropriated and applied to the purpose of paying the interest or principal of such indebtedness, or both, and to the extent that they will suffice, the direct tax may be remitted.

196. CONTRACTS—HOW LET.] § 11. All contracts for work to be done by such municipality the expense of which will exceed five hundred dollars shall be let to the lowest responsible bidder therefor upon not less than sixty days' public notice of the terms and conditions upon which the contract is to be let having been given by publication in a newspaper of general circulation published in said district, and the said board shall have the power and authority to reject any and all bids and readvertise: *Provided*, No person shall be employed on said work unless he is a citizen of the United States or has in good faith declared his intentions to become such citizen. In all cases where an alien, after filing his declaration of intention to become a citizen of the United States, shall for the space of three months after he could lawfully do so fail to take out his final papers and complete his citizenship, such failure shall be *prima facie* evidence that his declaration of intentions was not made in good faith. And that eight hours shall constitute a day's work.

197. TRUSTEES MAY LEVY AND COLLECT TAXES, ETC.] § 12. The board of trustees may levy and collect taxes for corporate purposes upon property within the territorial limits of such sanitary district, the aggregate amount of which in any one year shall not exceed one-half of one per centum of the value of the taxable property within the corporate limits as the same shall be assessed and equalized for State and county taxes of the year in which the levy is made. Said board shall cause the amount required to be raised by taxation in each year, to be certified by the county clerk, on or before the second Tuesday in August, as provided in section one hundred and twenty-two of the general revenue law. All taxes so levied and certified shall be collected and enforced in the same manner and by the same officers as State and county taxes, and shall be paid over by the officer collecting the same to the treasurer of the sanitary district in the manner and at the time provided by the general revenue law.

198. EXPENSES OF IMPROVEMENT—SPECIAL ASSESSMENTS—GENERAL TAX.] § 13. The board of trustees shall have power to defray the expenses of any improvement made by it in the execution of the powers hereby granted to such incorporation, by special assessment or by general taxation, or partly by special assessment and partly by general taxation, as they shall by ordinance prescribe. It shall constitute no objection to any special assessment that the improvement for which the same is levied is partly outside the limits of such incorporation, but no special assessment shall be made upon property situated outside of such sanitary district, and in no case shall any property be assessed more than it will be benefited by the improvement for which the assessment is levied. The proceedings for making, levying, collecting, and enforcing of any special assessment levied hereunder shall be the same as nearly as may be as is prescribed by article nine of an act entitled "An act to provide for the incorporation of cities and villages," approved April 10, 1872. Whenever in said act the words "city council" are used the same shall apply to the board of trustees constituted by this act, and the words applying to the city or its officers in that article shall be held to apply to the corporation hereby created and to its officers.

199. ASSESSMENT—INSTALLMENTS—INTEREST.] § 14. When any assessment is made under this act the ordinance authorizing such assessment may provide that it be divided into equal annual installments, not more than twenty in number, and fix the amount and time of payment of each installment, and that the installment shall bear interest at a rate not exceeding six per cent. per annum, payable annually, from the date fixed in said ordinance, and the several installments and interests thereon may be collected and enforced as they shall become due in the manner provided for the enforcement of assessments under said article 9. No more of any assessment need be returned or certified to the county collector than will show the amount due and unpaid at the time of such return, and no sale of any parcel of land for any installment of an assessment shall discharge the premises from any subsequent installment of the same or any other assessment. Any one or all of the installments may be paid any time after the assessment is confirmed, with accrued interest, if any, to the date of payment.

200. WHEN ASSESSMENTS PAYABLE BY INSTALLMENTS—BONDS MAY BE ISSUED.] § 15. Where any assessment is made payable in installments the board of trustees may issue bonds or certificates not exceeding in amount eighty per centum of the

unpaid portion of such assessment at the date of the issue thereof, payable only out of such assessment, and bearing interest at a rate not exceeding the rate of interest upon the installments of such assessments. The board of trustees shall have the right to call in and pay off said bonds or certificates as fast as there is money received into the treasury from the assessment against which the same are issued, and all moneys received upon such assessment shall be applied to the payment of said certificates or bonds until they are fully satisfied.

201. PRIVATE PROPERTY—HOW TAKEN FOR IMPROVEMENT.] § 16. Whenever the board of trustees of any sanitary district shall pass an ordinance for the making of any improvement which such district is authorized to make, the making of which will require that private property should be taken or damaged, such district may cause compensation therefor to be ascertained, and condemn and acquire possession thereof in the same manner as nearly as may be as is provided in an act entitled, "An act to provide for the exercise of the right of eminent domain," approved April 10, 1872: *Provided, however,* That proceedings to ascertain the compensation to be paid for taking or damaging private property shall in all cases be instituted in the county where the property sought to be taken or damaged is situated: *And provided,* That all damages to property, whether determined by agreement or by final judgment of court, shall be paid out of the annual district tax prior to the payment of any other debt or obligation.

202. MAY ACQUIRE RIGHT OF WAY.] § 17. When it shall be necessary in making any improvements which any district is authorized by this act to make, to enter upon any public property or property held for public use, such district shall have the power so to do and may acquire the necessary right of way over such property held for public use in the same manner as is above provided for acquiring private property, and may enter upon, use, widen, deepen, and improve any navigable or other waters, waterways, canal, or lake: *Provided,* The public use thereof shall not be unnecessarily interrupted or interfered with, and that the same shall be restored to its former usefulness as soon as practicable: *Provided, however,* That no such district shall occupy any portion of the Illinois and Michigan Canal outside of the limits of the county in which such district is situated for the site of any such improvement, except to cross the same, and then only in such a way as not to impair the usefulness of said canal, or to the injury of the right of the State therein, and only under the direction and supervision of the canal commissioners: *And provided further,* That no district shall be required to make any compensation for the use of so much of said canal as lies within the limits of the county in which said district is situated except for transportation purposes.

203. SPECIAL ASSESSMENT—DAMAGE TO PROPERTY, AND COST OF ACQUIRING.] § 18. In making any special assessment for any improvement which requires the taking or damaging of property, the cost of acquiring the right to damage or take such property may be estimated and included in the assessment as a part of the cost of making such improvement.

204. LIABILITY OF SANITARY DISTRICT FOR DAMAGES.] § 19. Every sanitary district shall be liable for all damages to real estate within or without such district which shall be overflowed or otherwise damaged by reason of the construction, enlargement, or use of any channel, ditch, drain, outlet, or other improvement under the provisions of this act; and actions to recover such damages may be brought in the county where such real estate is situate, or in the county where such sanitary district is located, at the option of the party claiming to be injured. And in case judgment is rendered against such district for damage the plaintiff shall also recover his reasonable attorney's fees, to be taxed as costs of suit: *Provided, however,* It shall appear on the trial that the plaintiff notified the trustees of such district, in writing, at least 60 days before suit was commenced by leaving a copy of such notice with some one of the trustees of such district stating that he claims damages to the amount of —— dollars, by reason of (here insert the cause of damage) and intends to sue for the same: *And provided further,* That the amount recovered shall be larger than the amount offered by said trustees (if anything) as a compromise for damages sustained.

205. CAPACITY OFCHANNEL OR OUTLET.] § 20. Any channel or outlet constructed under the provisions of this act which shall cause the discharge of sewage into or through any river or stream of water beyond or without the limits of the district constructing the same, shall be of sufficient size and capacity to produce a continuous flow of water of at least two hundred cubic feet per minute for each one thousand of the population of the district drained thereby, and the same shall be kept and maintained of such size and in such condition that the water thereof shall be neither offensive or injurious to the health of any of the people of this State, and before any sewage shall be discharged into such channel or outlet all garbage, dead animals, and parts thereof and other solids shall be taken therefrom.

206. SANITARY DISTRICT—FAILURE TO COMPLY WITH ACT—REMEDY—PENALTY.] § 21. In case any sanitary district in this State formed under the provisions of this

act shall introduce sewage into any river or stream of water, or natural or artificial water-course, beyond or without the limits of such district, without conforming to the provisions of this act, or having introduced such sewage into such water-course, shall fail to comply with any of the provisions of this act, an action to enforce compliance shall be brought by the attorney-general of this State in the courts of any county wherein such water-course is situate, or he may authorize the State attorney of any such county to commence and prosecute such action in any such county: *Provided*, That nothing in this section contained shall be construed to prevent the prosecution of any action or proceeding by individuals or bodies corporate or politic against such district.

207. ACT—HOW CONSTRUED.] § 22. Nothing in this act contained shall be so construed as to constitute a contract or grant between the State of Illinois and any sanitary district formed under its provisions, or to prevent, debar, or deprive the State of Illinois from, at any time in the future, altering, amending, or repealing this act, or imposing any conditions, restrictions, or requirements other, different, or additional to any herein contained upon any sanitary district which may be formed hereunder.

208. CHANNEL—HOW TO BE CONSTRUCTED.] § 23. If any channel is constructed under the provisions hereof, by means of which any of the waters of Lake Michigan shall be caused to pass into the Desplaines or Illinois River, such channel shall be constructed of sufficient size and capacity to produce and maintain at all times a continuous flow of not less than 300,000 cubic feet of water per minute, and to be of a depth of not less than fourteen feet, and a current not exceeding three miles per hour, and if any portion of any such channel shall be cut through a territory with a rocky stratum where such rocky stratum is above a grade sufficient to produce a depth of water from Lake Michigan of not less than eighteen feet, such portion of said channel shall have double the flowing capacity above provided for, and a width of not less than one hundred and sixty feet at the bottom capable of producing a depth of not less than eighteen feet of water. If the population of the district draining into such channel shall at any time exceed 1,500,000, such channel shall be made and kept of such size and in such condition that it will produce and maintain at all times a continuous flow of not less than 20,000 cubic feet of water per minute for each 100,000 of the population of such district, at a current of not more than three miles per hour, and if at any time the General Government shall improve the Desplaines or Illinois rivers, so that the same shall be capable of receiving a flow of 600,000 cubic feet of water per minute, or more, from said channel, and shall provide for the payment of all damages which any extra flow above 300,000 cubic feet of water per minute from such channel may cause to private property, so as to save harmless the said district from all liability therefrom, then such sanitary district shall, within one year thereafter, enlarge the entire channel leading into said Desplaines or Illinois rivers, from said district, to a sufficient size and capacity to produce and maintain a continuous flow throughout the same of not less than 600,000 cubic feet of water per minute, with a current of not more than three miles per hour, and such channel shall be constructed upon such grade as to be capable of producing a depth of water not less than eighteen feet throughout said channel, and shall have a width of not less than one hundred and sixty feet at the bottom. In case a channel is constructed in the Desplaines River, as contemplated in this section, it shall be carried down the slope between Lockport and Joliet to the pool commonly known as the upper basin, of sufficient width and depth to carry off the water the channel shall bring down from above. The district constructing a channel to carry water from Lake Michigan of any amount authorized by this act, may correct, modify, and remove obstructions in the Desplaines and Illinois rivers wherever it shall be necessary so to do to prevent overflow or damage along said river, and shall remove the dams at Henry and Copperas Creek, in the Illinois River, before any water shall be turned into the said channel. And the canal commissioners, if they shall find at any time that an additional supply of water has been added to either of said rivers, by any drainage district or districts, to maintain a depth of not less than six feet from any dam owned by the State, to and into the first lock of the Illinois and Michigan Canal at La Salle, without the aid of any such dam, at low water, then it shall be the duty of said canal commissioners to cause such dam or dams to be removed. This act shall not be construed to authorize the injury or destruction of existing water-power rights.

209. CHANNEL, WHEN COMPLETED—CONTROL OF.] § 24. When such channel shall be completed, and the water turned therein, to the amount of three hundred thousand cubic feet of water per minute, the same is hereby declared a navigable stream, and whenever the General Government shall improve the Desplaines and Illinois river for navigation, to connect with this channel, said General Government shall have full control over the same for navigation purposes, but not to interfere with its control for sanitary or drainage purposes.

210. MAY PERMIT TERRITORIES OUTSIDE TO DRAIN, ETC.] § 25. Any district formed hereunder shall have the right to permit territory lying outside its limits and within the same county to drain into and use any channel or drain made by it, upon

such payments, terms, and conditions as may be mutually agreed upon, and any district formed hereunder is hereby given full power and authority to contract for the right to use any drain or channel which may be made by any other sanitary district, upon such terms as may be mutually agreed upon, and to raise the money called for by any such contract in the same way and to the same extent as such district is authorized to raise money for any other corporate purposes: *Provided*, That where the united flow of any sanitary districts thus co-operating shall pass into any channel constructed within the limits of the county wherein such districts are located, and which passes into the the Desplaines or Illinois rivers, such united flow shall in no case and at no time be less than 20,000 cubic feet of water per minute for each one hundred thousand of the aggregate of the population of the districts co-operating: *Provided*, Nothing in this act shall in any wise be so construed as to diminish, impair, or remove any right or rights of any city, village, township, or corporation, body-politic or individual situated on the De-plaines or Illinois rivers or their tributaries and within the valleys of the same to use the channel for drainage or otherwise not inconsistent with the rights of the district constructing the same as expressed in this act.

211. WHEN CITY OR VILLAGE OWNS WATER-WORKS, ETC.] § 26. Whenever in any such sanitary district there shall be a city, incorporated town or village, which owns a system of water-works and supplies water from a lake or other source which will be saved and preserved from sewage pollution, by the construction of the main channel, drain, ditch, or outlet herein provided for, and the turning of the sewage of such city and district therein, and there shall be in such sanitary district any territory bordering on any such city, incorporated town or village within the limits of another city, incorporated town or village, which does not own any system of water-works, at the time of the creation of such sanitary district, then upon application by the corporate authorities of such latter-named city, incorporated town or village, the corporate authorities of such city, incorporated town or village having such system of water-works shall furnish water at the boundary line between such municipalities by means of its water-works to the corporate authorities asking for the same in such quantities as may be required to supply consumers within said territory, at no greater price or charge than it charges and collects of consumers within its limits for water furnished through meters in like large quantities.

212. WHEN CHANNEL CONSTRUCTED—COMMISSIONERS TO BE APPOINTED TO INSPECT ITS WORK.] § 27. If any channel shall be constructed under the provisions of section 23 of this act, it shall be the duty of the trustees of such district, where such channel shall be completed, and before any water or sewage shall be admitted therein, to duly notify, in writing, the governor of this State of such fact; and the governor shall thereupon appoint three discreet persons as commissioners, one of whom shall be a resident of the city of Joliet, or between said city and the city of La Salle, and one a resident of the city of La Salle, or between said said city and the city of Peoria, and one a resident of the city of Peoria, or between said city and the mouth of the Illinois River, to inspect said work. The said commissioners shall, within ten days after such appointment, meet at the city of Chicago, and shall appoint a competent civil engineer, and they may employ such other assistance as they may require to expeditiously perform their duties. The said commission shall take as their datum line for the survey the datum established by the Illinois and Michigan Canal Trustees in 1847, and shall make such examination and surveys of Chicago River and of the channel or channels authorized by this act as shall enable them to ascertain whether said channel is of the character and capacity required by this act. And in case they shall find the work in all respects in accordance with the provisions of section 23 of this act, they shall so certify to the governor, who shall thereupon authorize the water and sewage to be let into said channel. But in case said commissioners shall find said channel is not constructed in accordance with the provisions of this act, it shall be their duty to file in any court of competent jurisdiction, on the chancery side thereof, in their name as such commissioners, a bill against said corporation, which bill shall shall set forth wherein said work is deficient and fails to comply with the provisions of this act; and said court shall thereupon issue an injunction, without bond, against said defendant, enjoining and restraining it from admitting water or sewage into said channel until the final order of the court. And in case said court, upon hearing, shall determine that said channel is not constructed in accordance with the provisions of this act, said injunction shall be continued until the provisions of this act shall have been fully complied with.

Such commissioners and engineer shall receive for their services ten dollars per day each, and their reasonable expenses and outlays for the time by them necessarily employed in the discharge of their duties, which shall be paid to them from the State treasury; and the said sanitary district shall re-imburse the State for all expenses and disbursements on account of said commission.

If any channel is constructed under the provisions of this act which shall discharge the sewage of a population of more than 300,000 into or through any river beyond or

Galena
Rockford
Rock River
Clinton
Dixon
Aurora
CHICAGO
Fox River
Des Plaines River
Lake Michigan
Davenport
Rock Island
Hennepin Canal
Peru
Ottawa
Morris
Joliet
La Salle
Hennepin
Kankakee
Illinois River
Burlington
Peoria
Pontiac
Pekin
Keokuk
Bloomington
Havanna
Quincy
Beardstown
Decatur
Springfield
Hannibal
Grafton
Vandalia
Missouri River
ST. LOUIS
THE ILLINOIS WATERWAY.
LAKE MICHIGAN TO THE MISSISSIPPI RIVER
Works wholly in the State of Illinois may be of greater benefit to the Mississippi than their cost directly applied.
Mississippi River
Hamilton
Wabash River
Ohio River
Cairo
A. Zeese & Co. Engrs. Chi.

without the limits of the district constructing it, the same shall be constructed in accordance with the provisions of section 23 of this act, and if any such channel receives its supply of water from any river or channel connecting with Lake Michigan it shall be construed as receiving its supply of water from Lake Michigan.

UNITED STATES.

Improvement of the Illinois and Desplaines rivers.

Sec.
18. Repeal.
19. Works ceded to the United States on condition.
20. Conditions—removal of dam.
21. Basis of act of cession.

AN ACT in reference to the improvement of the Illinois and Desplaines rivers, and to repeal an act entitled "An act to cede certain locks and dams in the Illinois River to the United States," approved May 31, 1887, in force May 31, 1887. Approved June 4, 1889. In force July 1, 1889.

18. REPEAL.] § 1. *Be it enacted by the people of the State of Illinois, represented in the general assembly*, That an act entitled "An act to cede certain locks and dams in the Illinois river to the United States," approved May 31, 1887; in force May 31, 1877, and ceding the State works at Henry and Copperas Creek, and the pools created by said works, to the General Government upon certain conditions as to the opening of a water-way of a depth of seven feet from the Mississippi River to Lake Michigan, upon plans to be determined by the United States engineers, is hereby repealed.

19. WORKS CEDED TO THE UNITED STATES ON CONDITION.] § 2. That the State works at Henry and Copperas Creek, and the river now slackwatered by said works, are hereby ceded to the United States, on condition that the dams shall be removed whenever the depth now available for navigation can be secured and maintained by channel improvement without the aid of said dams: *Provided*, That said depth shall be assured upon the removal of said dams, or that such removal shall not materially impair navigation.

20. CONDITIONS—REMOVAL OF DAM.] § 3. That in the event of the non-acceptance of these works upon the conditions mentioned in section 2, within four (4) years after this act becomes a law, the canal commissioners of the State of Illinois are authorized and instructed to remove the dams at Henry and Copperas Creek.

21. BASIS OF ACT OF CESSION.] § 4. That the State of Illinois bases this act of cession upon the condition that the plan of improving the Illinois River below La Salle by slackwater maintained by dams and locks, be changed to a plan of improvement by means of an open channel in conjunction with a water supply from Lake Michigan,

[This act is in place of sections 18 and 19, on page 1321, Hurd's Revised Statutes, 1887.—ED.]

JOINT RESOLUTION.

Whereas the present addition to the low-water volume of the Illinois River through the summit level of the Illinois and Michigan Canal from Lake Michigan more than doubles the volume of water used in the estimate of 1868 for the channel below Peru, and adds 50 per cent. to the volume used in the estimate of 1880 for the channel below Copperas Creek, and said contribution from Lake Michigan will be increased in the immediate future, thus enabling the depth now projected for navigation below Peru to be obtained by channel improvement at moderate cost, and with decided advantage to material interests and to healthfulness along the valley.

Whereas it is contemplated to increase the volume from Lake Michigan to 300,000 cubic feet per minute within a few years, and ultimately to add 600,000 cubic feet or more, thus enabling a large depth for navigation to be obtained by an improved channel, and that said channel will be self-sustaining and self-improving, and will discharge flood-waters more readily, thus benefiting the bordering lands and increasing the healthfulness of the valley.

Whereas works now projected by the city of Chicago will form part of a water-way of large proportions from Lake Michigan via the Des Plaines and Illinois rivers to the Mississippi River, of which the dams and locks upon the alluvial section of the Illinois River can form no part, and which, if allowed to remain, will increase, overflow, and be detrimental to the welfare of the Illinois Valley and the interests of the State: Therefore, be it

Resolved by the Senate, the House of Representatives concurring herein:

1. That it is the policy of the State of Illinois to procure the construction of a water-way of the greatest practicable depth and usefulness for navigation from Lake

Michigan via the Des Plaines and Illinois rivers to the Mississippi River, and to encourage the construction of feeders thereto of like proportions and usefulness.

2. That the United States is hereby requested to stop work upon the locks and dams at La Grange and at Kampsville, and to apply all funds available and future appropriations to the improvement of the channel from La Salle to the mouth, with a view to such a depth as will be of present utility, and in such manner as to develope progressively all the depth practicable by the aid of a large water supply from Lake Michigan at Chicago.

3. That the United States is requested to aid in the construction of a channel not less than 160 feet wide and 22 feet deep, with such a grade as to give a velocity of 3 miles per hour from Lake Michigan at Chicago to Lake Joliet, a pool of the Des Plaines River immediately below Joliet, and to project a channel of similar capacity and not less than 14 feet deep from Lake Joliet to La Salle, all to be designed in such manner as to permit future development to a greater capacity.

JJ 4.

IMPROVEMENT OF THE CALUMET RIVER, ILLINOIS AND INDIANA.

The object of this improvement, as far as at present authorized, is to secure a channel 200 feet wide and 16 feet deep, from the mouth of the river to one-half mile east of Hammond, Ind., to increase the facilities for handling the commerce of this region, and afford relief to the overcrowded port of Chicago.

The river and harbor act of July 5, 1884, appropriated $50,000 for the improvement of the section of the river from the mouth to the outlet of Lake Calumet, with the following proviso:

That no part of said sum shall be expended until the right of way shall have been conveyed to the United States free from expense, and the United States shall be fully released from all liability for damages to adjacent property owners, to the satisfaction of the Secretary of War.

The river and harbor act of August 5, 1886, appropriated a further sum of $30,000 for the improvement of the river, and made available $11,250 of the same to be expended above the forks of the Calumet, in Illinois and Indiana, but continued the restrictions upon the expenditure of the balance.

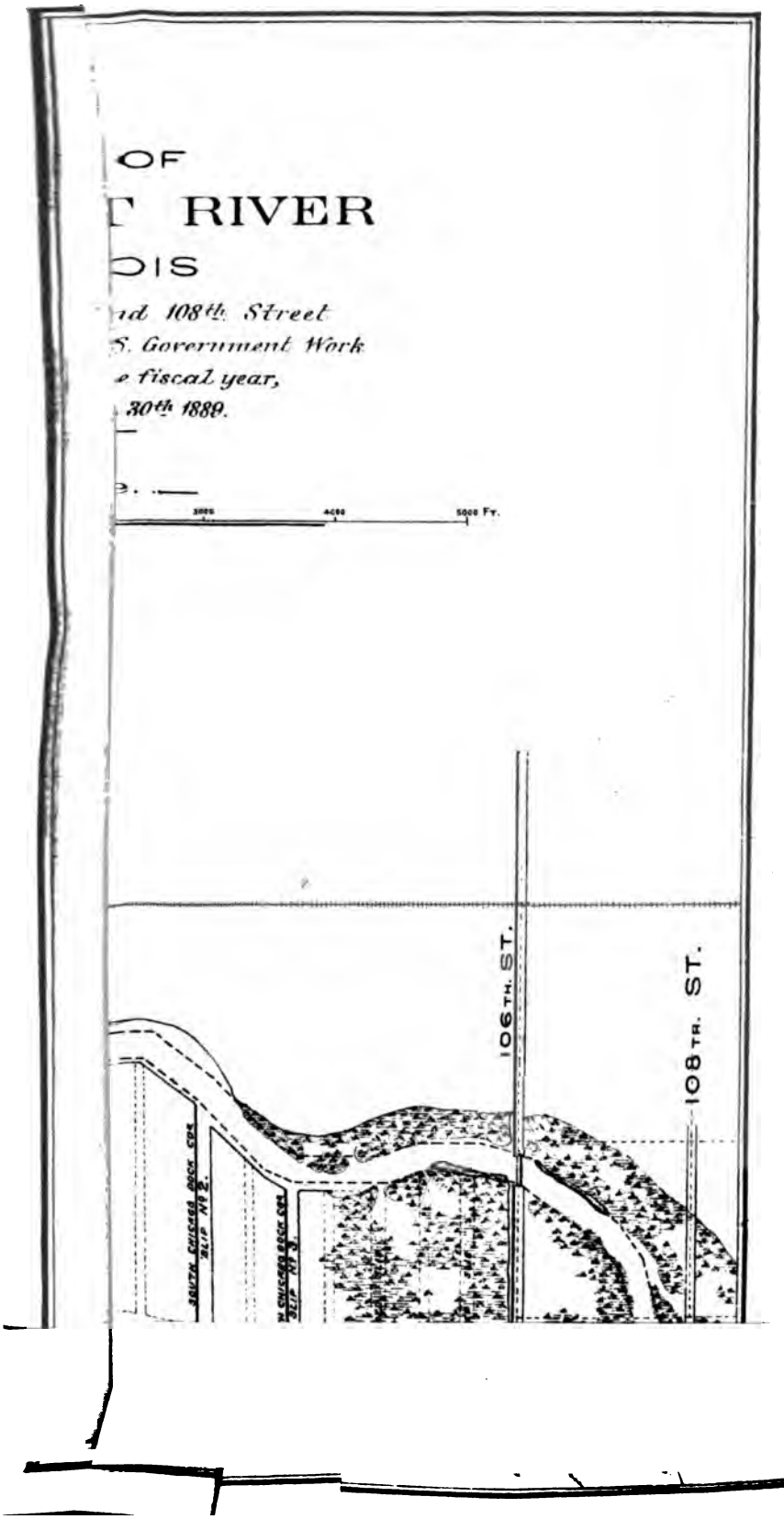
The river and harbor act of August 11, 1888, made a further appropriation of $50,000, of which $15,000 is—

to be used in improving the river above the forks to one-half mile east of Hammond, and $35,000 for the improvement of the river between its mouth and One hundred and eighth street.

The amount heretofore appropriated for the improvement of said Calumet River from its mouth to its forks, or so much thereof as may be necessary, shall be immediately available for the improvement between its mouth and One hundred and eighth street, anything in the act of July 5, 1884, and August 5, 1886, to the contrary notwithstanding.

The projects for improving the Calumet River contemplate the ultimate depth of 16 feet below the United States harbor datum for both sections; but the amounts appropriated for the upper section being small, it has been decided, with the approval of the Chief of Engineers, to devote this sum to securing a depth of ten feet at the shallow points over a practicable width of channel in order to meet, as far as practicable, the pressing necessities of the existing commerce upon that section.

An examination of the lower section from the mouth to One hundred and eighth street showed that the funds on hand and made available would probably be sufficient to complete the improvement.


OF
T RIVER
DIS
nd 108th Street
S. Government Work
e fiscal year,
30th 1889.
5000 Ft.
106TH. ST.
108TH. ST.

Accordingly, with the approval of the Chief of Engineers, separate sealed proposals for dredging in the two sections of the river named were solicited, and opened October 10, 1888, and contracts entered into with the lowest responsible bidders, with the approval of the Chief of Engineers, as follows:

(1) *Lower section, from the mouth to One hundred and eighth street.*—Contract was entered into November 5, 1888, with W. A. McGillis & Co. for the work, at 11¾ cents per cubic yard. Work began May 4, 1889, with one dipper-dredge and one scow. Afterwards the plant was somewhat increased, but up to the close of the fiscal year ending June 30, 1889, no sufficient progress has been made. The contractors have been unable to complete the construction of the plant required in time to comply, as yet, with the requirements of their contract, and have, consequently, received no estimates or payments for the 24,608 cubic yards that they have removed. They are building a large elevator-dredge, with the estimated capacity of from 6,000 to 10,000 cubic yards per day, which is expected to begin work in July, 1889. The total amount of material to be removed under their contract is 770,000 cubic yards. The contract requires 4,000 cubic yards per day to be removed, but so far the work performed does not average above one-tenth of this quantity. It is hoped, however, that the large elevator-dredge, now nearly completed, will enable the contractors to comply with the requirements of their agreement.

(2) *Upper section, between the forks and one-half mile east of Hammond, Indiana.*—Contract was entered into October 31, 1888, with Burdick & McMahon, of Chicago, Ill., at 22 cents per cubic yard. Work began under this contract May 7, 1889, at the junction of the Grand and Little Calumet rivers, and up to the close of the fiscal year ending June 30, 1889, 34,523 cubic yards of material had been removed from the channel, forming a practicable channel through an obstructed reach of the river from 30 to 50 feet in width and 10 feet in depth, extending from the junction up to the Pennsylvania Railroad Company's Bridge. The accompanying maps show the location of the work.

By a recent vote of the inhabitants interested, a large part of the Calumet region has been annexed to the city of Chicago. This will undoubtedly greatly stimulate the development of this region, and work now contemplated by the city of Chicago for local drainage, and authorized by recent acts of the Illinois legislature, will, it is thought, have such an effect upon the navigability and navigation of the Chicago River that much of the commerce that now uses Chicago River must seek other accommodations, and will undoubtedly be diverted to the Calumet River and Harbor. It is, then, very desirable that the improvement of this stream be continued, and that entire control over it for purposes of navigation, and of the bridges, especially, that span and obstruct it, be assumed by Congress. Attention is invited to the report of Assistant G. A. M. Liljencrantz as to the injury to dredged channels caused by the dumping into them of slaughter-house refuse, which again fills up the dredged channels in a very short time.

PROPOSED APPLICATION OF FUNDS NOW AVAILABLE, AND THOSE ASKED FOR, FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

The United States district attorney for the northern district of Illinois, having secured the deeds and releases required by the act of July 5, 1884, and August 5, 1886, from property owners between the mouth of the Calumet River and the forks of the Calumet, which deeds and

releases have been accepted by the proper authorities of the United States as sufficient, and filed and recorded, there is no further difficulty in the way of the improvement as far as the lower section is concerned. The funds now available will be required to pay for the continuance of the work under existing contracts. The amount asked for the fiscal year ending June 30, 1891, is to be applied to the general project of improving Calumet River by dredging so as to improve equally and progressively the channel from the mouth to one-half mile east of Hammond, Ind., with a view to securing ultimately a channel 16 feet deep and 200 feet wide throughout the section appropriated for.

The estimated total cost of this improvement, if done by contract, which system is recommended, is $1,000,000.

The estimate is for both the upper and lower sections of the river, that have been appropriated for, and includes the entire stretch from One hundred and eighth street, the terminus of the part now being improved, to one-half mile east of Hammond, Ind.

Money statement.

July 1, 1888, amount available		$69,029.18
Received from sale of fuel to officer		22.50
Amount appropriated by act of August 11, 1888		50,000.00
		119,051.68
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$14,613.19	
July 1, 1889, outstanding liabilities	100.17	
July 1, 1889, amount covered by existing contracts	97,939.44	
		112,652.80
July 1, 1889, balance available		6,398.88
Amount (estimated) required for completion of existing project		870,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

The amount reported as available July 1, 1888, $68,904.48, is found to have been in error, being $124.70 too small.

Abstract of proposals for dredging in Calumet River between the forks and one-half mile east of Hammond, Ind.

[Received and opened at Chicago, Ill., October 10, 1888, by Capt. W. L. Marshall, Corps of Engineers.]

No.	Name and address of bidder.	Dredging 80,000 cu. yds. (estimated), per cu. yd.	Total.
		Cents.	
1	The Fitz Simons and Connell Co., Chicago, Ill	25	$20,000
2	Samuel O. Dixon, Racine, Wis	28	22,400
*3	Burdick & McMahon, Chicago, Ill	22	17,600
4	Dodge & Petrie, Chicago, Ill	27	21,600
5	Chicago Dredging and Dock Company, Chicago, Ill	24	19,200
6	Green's Dredging Company, Chicago, Ill	24½	19,600

* Accepted and contract made, dated October 31, 1888.

Abstract of proposals for dredging in Calumet River between its mouth and One hundred and eighth street.

[Received and opened at Chicago, Ill., October 10, 1888, by Capt. W. L. Marshall, Corps of Engineers.]

No.	Name and address of bidder.	Dredging 77,000 cu. yds. (estimated), per cu. yd.	Total.
		Cents.	
1	Williams, Upham & Co., Duluth, Minn	28	$169,400
2	The Fitz Simons and Connell Co., Chicago, Ill	20	154,000
3	Samuel O. Dixon, Racine, Wis	19¼	148,225
*4	W. A. McGillis & Co., Havana, Ill	11¾	90,475
5	Alabama Dredging and Jetty Company, Mobile, Ala	14 7/10	114,730
6	Chicago Dredging and Dock Company	19½	150,150
7	Green's Dredging Company, Chicago, Ill	18	138,600

*Accepted and contract made, dated November 5, 1888.

Abstract of contracts for improving Calumet River, Illinois and Indiana, in force during the fiscal year ending June 30, 1889.

Name and address of contractor.	Nature of contract.	Date.	To expire.
Burdick & McMahon, Chicago, Ill	Dredging above the forks	Oct. 31, 1888	Nov. 30, 1889
W. A. McGillis & Co., Kankakee, Ill	Dredging between the mouth and 108th street.	Nov. 5, 1888	Do.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 3, 1889.

CAPTAIN: I have the honor to submit herewith a report on the improvement of Calumet River, Illinois and Indiana, for the fiscal year ending June 30, 1889.

Surveys of the Calumet River were made in 1881 and 1885, which were then reported on in detail. The former of these surveys comprised the portion of the river between the mouth and the "forks," at Lake Calumet, the latter between said "forks" and one-half mile east of Hammond, Ind.

The upper half of the last stretch, or from the junction with Little Calumet to the easterly terminus at Hammond, forms a part of what is known as Grand Calumet.

Three appropriations have been made for the improvement of this river, viz, in 1884, 1886, and in 1888. The first of these included a proviso prohibiting the expenditure of any part thereof until releases had been conveyed to the United States Government for right of way and from damages to adjoining property. The second appropriation contained the same proviso as concerning the part of the river surveyed in 1881, but made an exception for the upper part, for which a certain amount, $11,250 was allotted, with authority to expend one-half, or $5,625 in Illinois, and the other half at Hammond, in Indiana. The third appropriation made by river and harbor act of August 11, 1888, authorized the expenditure of moneys then and previously appropriated for the part of the river between the mouth and One hundred and eighth street, releases from property owners having been received and approved for that distance. A certain portion, $15,000 of the appropriation of $50,000 then made, was ordered to be expended in improving the river between the "forks" and one-half mile east of Hammond, Ind. With regard to funds available, and the work of improvement, the river is thus divided into two distinct sections, corresponding respectively to the parts surveyed in 1881 and 1885, and which, for convenience sake, I will designate in this report as the "lower" and "upper" sections. As the work in the different sections has been done by different contractors, in different manner, and with different results, the reports for the two will be made separately.

THE LOWER SECTION, BETWEEN THE MOUTH OF THE RIVER AND ONE HUNDRED AND EIGHTH STREET.

Bids for dredging the lower section of the river were received and opened October 10, 1888, and the contract awarded to W. A. McGillis & Co. of Havana, Ill., their bid being 11¾ cents per cubic yard. Actual work did not commence until May 4, 1889.

The contractor had been building a new plant for this work, only a portion of which was completed on the above date. This consisted in the dipper dredge and one dump scow. Another dump scow was added to the plant the 20th. With this outfit only from 400 to 500 cubic yards of material per day were removed. Breakages of the plant occurred frequently, and at the close of the month so little work had been done that no estimate was given the contractor.

Another dredge, of the elevator kind, was started in later and experimented with, but without appreciable results. It was laid up for repairs most of the time, and finally abandoned.

On the 25th of June, the contractor secured an additional dipper dredge and two more dump scows, thereby increasing the daily average of dredging to about 1,400 cubic yards, which, however, is far below the amount required by the contract. I would have considered it my duty to recommend that the contract be considered forfeited, were it not for the fact that another new elevator dredge is just about completed, the capacity of which is claimed to be from 6,000 to 10,000 cubic yards per day, and by which the contractor expects to redeem his obligations. A trial of this dredge will be made in a few days, when a more definite opinion can be formed as to the ability of the contractor to fulfill the requirements of his contract.

No estimate has as yet been given the contractor. The dredging of the lower section is to be made to a depth of 16 feet below low water, and 200 feet in width, according to the project approved.

THE UPPER SECTION, BETWEEN THE FORKS AND ONE-HALF MILE EAST OF HAMMOND, INDIANA.

The amounts appropriated for the upper section in 1886 and 1888 were both comparatively small. It was, therefore, considered to the best interest of those navigating the river, to dredge in the shallowest places a channel sufficiently deep and wide to accommodate the present wants, as far as funds available would allow. Accordingly, dredging was done in 1887 to a depth of 10 feet, and from 30 to 50 feet in width where most needed, and which places are shown on the sketch, except at Hammond, Ind., where the full width of 200 feet and 500 feet in length was made to form a turning-basin for vessels; the depth was made 10 feet here as elsewhere.

The same principle has been adhered to in the expenditure of the funds appropriated in 1888. Bids for dredging this section were received and opened October 10, 1888, and the contract awarded to Messrs. Burdick & McMahon, of Chicago, Ill., at a contract price of 22 cents per cubic yard.

On the 7th day of May, 1889, the contractors commenced work at the junction of Little Calumet River with the main branch, a place which has for years been a serious obstruction to navigation on account of the deposit from the Little Calumet, which, entering almost at right angles to the main branch, had formed a bar around which boats were compelled to make a sharp turn up into the mouth of Little Calumet and back to get into the Grand Calumet toward Hammond. From the junction and up to the Pennsylvania Company's Bridge, the shallow channel has been deepened to 10 feet or more, with a width of from 30 to 50 feet, during the months of May and June, by the removal of 34,523 cubic yards of material therefrom.

The plant used consists in a dipper dredge and a sluice arrangement by which the material is forced up on to the adjoining low and marshy ground.

Since the beginning of the improvement of this section there has been removed:

	Cubic yards.
In 1887 to 1888, in Illinois	36,789
In 1887 to 1888, in Indiana	37,744
In 1889, in Illinois	34,523
Total	109,056

The places where it is proposed to do further work, as far as available funds will allow, are indicated on the sketch herewith.

GENERAL REMARKS.

Two new bridges have been built across the river during the year, viz, one wagon road bridge as a substitute for the old and primitive structure at One hundred and sixth street, and one double-track railway bridge half a mile west of the Illinois and Indiana State line, for the Chicago and Calumet Terminal Railroad. Sketches showing locations on the river, and the general character of construction of these bridges are submitted herewith.

The benefit to navigation of the dredging done between the Hammond Railway bridges and the State line in 1888, is being rapidly diminished by the promiscuous

dumping of refuse from the slaughter houses at that place, whereby the dredged channel is fast filling up.

New enterprises are constantly being established along the river, and many concerns of considerable magnitude and importance are only waiting for the development of the river improvement before deciding upon locating in this promising region. A great portion of the river having just, by annexation, become a part of the city of Chicago, will probably increase its value for location of various manufacturing establishments, thereby relieving the already overcrowded Chicago River.

Prominent among enterprises established along the river during the past year, are—

Corey's Manufacturing Company for railway car supplies, south of Burnham, on the south side of the river, with two buildings, respectively 55 by 50 feet, and 25 by 30 feet, finished, and three large buildings in progress.

The Compound Lumber Company, at Burnham, has 900 feet dock frontage, which will all be occupied with buildings for the manufacture of their "compound wood," a combination of soft and hard wood, after a new patent, for use in interior of buildings, etc. They have built a dock 340 feet in length, which is soon to be extended.

Hammond Sash and Blind Company, located east of Hammond wagon bridge, south of the river, where they have built a dock 500 feet in length.

George H. Hammond & Co. have made considerable extensions to their slaughter houses at Hammond.

Among prominent enterprises decided upon is, foremost, a large mill for rolling plates for iron steam-ships, adjoining the North Chicago Rolling Mill Company, at South Chicago, where it is expected to invest some $2,000,000.

Contemplated enterprises are a ship-yard for the construction of iron steam-ships and others.

SURVEYS.

Mr. Paul Heinze was appointed overseer of Calumet River, and charged with the duty of surveying the river, laying out the work for both contractors, and taking soundings in the river channel before and after dredging operations, wherefrom estimates were to be made.

This work has been done as follows:

(1) *In the "lower section" of the river.*—A careful survey has been made of the first mile of the river, counting from the mouth, and a map to a scale of 1 inch = 200 feet plotted of the same.

The channel lines have been defined in the field for a distance of 6,500 feet along the river. One hundred and eighteen cross-sections 50 feet apart have been established, and soundings taken 10 feet apart on each of these. Seven cross-sections have also been sounded after the dredging at the mouth of the river.

(2) *In the "upper section."*—The channel lines were established, as well as 108 cross-sections 50 feet apart, for an aggregate distance of 5,250 feet, or approximately 1 mile, from the mouth of Little Calumet River and along the town of Burnham. Soundings were taken before dredging on all these cross-sections. Soundings after dredging were taken where dredging had been completed, or over a distance of 3,300 feet, comprising 69 cross-sections.

I am, captain, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

As the Calumet River and Harbor are so closely connected in their commercial relations no commercial statistics are given in this place, but will be found under the head of Calumet Harbor. There is now practically no navigation on the river beyond that at the harbor. As soon, however, as the river channel is opened by dredging, navigation and business along the river will develop very fast. It awaits only this opening.

JJ 5.

LOCATION OF THE ILLINOIS AND MISSISSIPPI CANAL.

The river and harbor act of August 11, 1888, contains the following provision:

> The Secretary of War is further authorized and directed to cause to be located, on such line as he may approve, a canal from the Illinois River, at or near the town of Hennepin, to the Mississippi River, at or above the mouth of Rock River, together with a necessary feeder for the same, said canal to be known as the Illinois and Mississippi Canal, and to be 80 feet wide at the water-line, and to have a depth of not less than 7 feet of water, with locks 170 feet long and 30 feet wide. The Secretary of War shall cause to be made and submitted to Congress detailed plans and estimates for the construction of said canal and feeder; the necessary expense of making such location, plans, and estimates shall be paid out of the unexpended balance on hand heretofore appropriated for the survey of said canal by the river and harbor act approved August 5, 1886, for the examination of said canal and of the Illinois and Michigan Canal by a Board of Engineers.

This act changes the name of the proposed canal from the "Hennepin Canal," under which name former surveys, reports, and estimates have been made to Congress, to the "Illinois and Mississippi Canal."

After the amounts appropriated by the act in question had been made available, information was sought from the Chief of Engineers as to (1) the meaning of the word "locate," and, (2) as to the line that meets the approval of the Secretary of War.

The Secretary of War, by indorsement dated October 27, 1888, designated the Rock Island route, and it was held "that the word 'locate' means to designate the site or place of the proposed canal upon maps compiled from surveys sufficiently in detail to furnish a careful estimate of the cost of the work, and does not contemplate the staking out of the works upon the ground."

Accordingly, under the projects approved by the Chief of Engineers, work was begun in the office, January 2, 1889, in compiling from the maps of previous surveys of the Hennepin Canal heretofore submitted to Congress (see Report of Chief of Engineers, 1883, page 1754; 1886, page 1708) maps in sufficient detail, and to proper scale, to show the proposed location of the "Illinois and Mississippi Canal," and in designing, drawing, and estimating the cost of the various mechanical constructions necessary to establish the proposed navigation along the line.

The route via Penney's Slough and the Rock River was selected as the most economical and capacious, and up to the close of the fiscal year ending June 30, 1889, the following work has been done in the office. There have been completed the following drawings: Thirteen sheets, each 30 by 40 inches dimensions, each showing four miles of the location of the proposed canal, and drawn to a scale of 1 inch equals 600 feet. Eight sheets, same dimensions, of detailed drawings for locks of various lifts, with details of foundations, gates, valves, and maneuvering gear. Five sheets, same dimensions, detailed drawings of aqueduct bridges along the main lines, including all aqueduct bridges along the main route. Two sheets, same dimensions, of details of culverts, both masonry and pipe culverts, along the main line.

Also detailed drawings to larger scale, as follows: Six sheets, scale 1 inch equals 40 feet, showing sites for the aqueduct bridges. Six profiles of the same crossings. One sheet showing sites for locks No. 28 and 29. One profile of same. One sheet showing Pond Creek Valley.

In the progress of the work, it early became apparent that addi-

tional surveys would be required at various points on the line to supply sufficient information to allow definite detailed plans and estimates to be made, and the line definitely located, especially at the following parts of the line: Bureau Creek Valley from the Illinois River to the Summit level, near the mouth of Rock River, along the feeder, near Dixon on Rock River, and special surveys of sites of work at various points.

As it is desirable that the surveys near Dixon, and at the mouth of Rock River be made at low water, they have not yet been made, awaiting a proper season.

The survey of the Bureau Creek Valley was made under direction of Assistant Engineer G. A. M. Liljencrantz in March, 1889, and the maps of the survey have been drawn. Reference is made to his report for details of this survey, as well, also, of the office work.

Mr. Liljencrantz has been in charge of the "location" of the canal. The mechanical constructions have been designed by myself, and drawn by Mr. John C. des Granges, who has also worked out many of the minor details of these works.

All of the constructions along this line are to be of permanent character, except the gates of the locks, the lining of aqueduct trunks, and the submerged parts of dams in Rock River, which are of wood.

All other parts of the canal and works are of stone, earth, iron, and concrete.

The entire line will require an atlas of 72 sheets to exhibit the location and plans. A descriptive memoir with specifications and estimates will accompany the atlas.

The great amount of detail, in draughting and designing, required for a work of this magnitude, where the mechanical constructions are so numerous and varied, will necessarily delay the final submission of these plans and estimates probably until near the close of the fiscal year ending June 30, 1890. But few men can be employed upon the work advantageously, and it can not well be hurried.

The funds on hand and available for the work are sufficient for its accomplishment.

Money statement.

July 1, 1888, amount available	$14,497.44
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	4,761.61
July 1, 1889, balance available	9,735.83

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 5, 1889.

CAPTAIN: I have the honor to submit herewith a report on work done for the location of the Illinois and Mississippi Canal during the fiscal year ending June 30, 1889.

The river and harbor act of August 11, 1888, ordered the "location of the Illinois and Mississippi Canal," hitherto known as the "Hennepin Canal."

In conformity to information received from you, the route selected was the one to Rock Island via Penney's Slough, and the word "location" was to be understood as meaning the preparation of maps from surveys already made of the selected route, and of detail constructions of locks, aqueducts, culverts, etc., for said route.

When proceeding with these constructions, it was found necessary to secure more definite elevations of water levels and other data in Bureau Creek Valley. It was also learned that several changes of various kinds had occurred since the survey of

1882, which would directly and materially affect the construction of the canal. I therefore proceeded, agreeably to your instructions, with a party of seven, to Bureau Creek Junction, on the 18th of March, and ran a transit line as near as practicable, to the line located on the bases of the survey of 1882, starting about a mile from the original initial point at Illinois River, and closing shortly before reaching the twentieth mile, on the summit level, April 2, 1889. Mr. Paul Heinze served in the capacity of transitman and topographer, and Mr. J. C. Nickson as leveler.

The principal aims of this survey were to secure—

(1) As complete elevations of the traversed territory as practicable, so as to obtain reliable contour lines;

(2) Accurate elevations and cross-sections of all water-courses crossed by the line;

(3) Cross-sections of culverts made for said water-courses under the railroad along which the said canal route is located; and, finally,

(4) Account of all noteworthy changes, natural or otherwise, that had taken place since 1882, and determine what effect these would have on the proposed canal construction.

The elevations and cross-sections obtained have furnished the needed aid in determining upon the dimensions and locations for culverts and aqueducts, etc.

Many changes of different kinds were discovered along the line, some of which were of considerable importance. The more prominent of these are—

(1) The addition of one track to the Chicago, Rock Island and Pacific Railroad alongside of the old one for the whole distance followed by the canal route, *i. e.*, from Bureau Junction to beyond Pond Creek Station. As the canal was already, by adjacent high hills, forced undesirably close to the railroad in many places—notably in Pond Creek Valley—this change must be considered as very unfavorable for the canal.

(2) The changing of the wagon road from the south to the north side of the railroad, between D. S. Miller's farm on the second mile and the Leepertown Mill. This change was suggested and estimated for in report of 1882, an expense from which the Government is thus relieved.

(3) The cut off of a big bend in the West Bureau Creek, in sections 26 and 35 of Wyant Township, on the thirteenth mile, by the Chicago, Rock Island and Pacific Railway Company, and the substituting for the old crooked channel a new straight cut south of its line, in 1884.

(4) The abandonment of water-power for most of the mills along the route, some of which have been either torn down or left to decay. One or two have exchanged their water-power for steam-power, and in most cases are their head and tail races dried up or filled up with sand.

(5) The hill south of the railroad, near Leepertown Mill, around which the line of 1882 was laid, was purchased by the railroad company for a gravel-pit, and has been cut down below the level of the surrounding land.

(6) The Bureau Creek and its branches have changed their boundary lines by action of the current in the bends in several places, in some quite considerably.

These and other circumstances have suggested various alterations from the plans proposed in report of 1882.

The principal changes now proposed are as follows:

(1) The substitution of a pivot bridge at the crossing of the Peoria branch of the Rock Island road near Bureau Junction for the arch proposed in 1882, as the required 15 feet perpendicular in the clear, above high water, can not be obtained without raising the railway track at the crossing at least 8 feet.

(2) The crossing of the main line of the Rock Island road at Leepertown Mill changed to 3¼ miles further west. This change is proposed to make a more favorable angle with the railroad; to avoid the enormous excavations through two hills north of railroad, which are from 90 to 130 feet above the proposed canal bottom, and, finally, the old Leepertown Mill being abandoned and in ruins, its tail-race partly dried up, need not be considered as such, but can be crossed over without any other provision than a comparatively small culvert, large enough to admit ordinary surface drainage. The hill south of the railroad having been changed into a pit, as mentioned above, the canal can continue its straight course uninterruptedly, the ground all along and south of the railroad being quite even and of favorable elevation.

(3) The straightening of the line where, as before stated, the railroad company had made the cut-off from West Bureau Creek. To avoid two aqueducts at this place the canal route was laid around the bend of the river through the sides of some very high and steep sand hills, between which flowed a number of tributary rivulets, each requiring a culvert. The straightened channel will require only one good-sized culvert, at the lower crossing, to take the place of the five culverts estimated for in 1882, by the small tributaries all passing through the old river-bed.

(4) Some slight alterations of minor importance have been made, as suggested by changes in the course of Bureau Creek or its branches. In consequence, some changes to correspond have been made in the location of locks, culverts, and other structures.

The preparation of maps and plans of the different structures required, with detail estimates of materials and labor, comprised the principal work to be done in locating the proposed canal.

The maps of 1882 were to be reduced to a suitable scale (1 inch to 600 feet) to be conveniently shown on a series of sheets of uniform size, the same as adopted for the plans of the various structures, viz, 30 inches by 40 inches. Each map contains 4 miles of the canal route, with corresponding profile, and tables of the structures belonging to the respective 4 miles.

The preparation of maps and plans commenced at the beginning of the calendar year. It was estimated that the number of sheets required would be as follows:

	Sheets.
For maps, including one index map	31
For locks, with details	15
For aqueducts, with details	8
For culverts	3
For railway bridges, with details	5
For highway bridges, with details	5
For dams, with details	3
For sluice-ways and weirs	2
Total	72

To these will be added sheet for title, index, etc., to put the whole collection into the shape of a convenient atlas.

Of the above sheets the following have been completed during the fiscal year, save some lettering, tables, etc.:

	Sheets.
Maps	13
Lock drawings	8
Aqueducts	5
Culverts	2
Total	28

Detail estimates have also been made for the locks and aqueducts constructed.

Besides maps and drawings above accounted for, the following detail drawings have been made to extra large scale, for cases where more minute information was needed than could be obtained from those made to the smaller scale, viz: 6 sheets, showing sites for the aqueducts (scale 1 inch to 40 inches); 6 profiles for same (horizontal scale 1 inch to 40 inches, vertical scale 1 inch to 3 inches); 1 sheet, showing site for Locks No. 28 and 29 (1 inch to 40 inches); 1 profile for same (scales same as for profiles above); 1 sheet, showing Pond Creek Valley (scale 1 inch to 100 inches); or in all fifteen detail drawings.

I am, captain, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

J J 6.

PRELIMINARY EXAMINATION OF GRAND CALUMET RIVER, INDIANA, BEGINNING ONE-HALF MILE EAST OF HAMMOND, AND THENCE EASTWARD TO LAKE MICHIGAN.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., December 10, 1888.

GENERAL: I have the honor to submit the following report of a preliminary examination of the "Grand Calumet River, Indiana, beginning one-half mile east of Hammond, and thence eastward to Lake Michigan," made in accordance with the requirements of the river and harbor act of August 11, 1888.

The examination was made under my direction by assistant G. A. M. Liljencrantz, whose report with map is herewith.

From this report and map the following facts appear:

That this part of the Grand Calumet River, 13½ miles long in direct line and 15 miles in length along the meanders of the stream, is a portion of a dead river, wandering from side to side of a marsh 600 to 1,400 feet in width lying between Hammond, Ind., and its old mouth now closed by sand; that for 9 miles of this distance below Hammond, or to the Lake Shore and Michigan Southern Railroad Bridge, the channel, with the exception of a few short stretches, averages 10 feet depth, over 3 miles of which there is a navigable channel exceeding 13 feet in depth; that the lower 6 miles is crooked, narrow, and more shallow, varying in width from a mere thread of water to wide sloughs or lagoons, and in depth from 1 to 10 feet, the bottom of the river consisting of mud, with occasionally a little sand or clay; that the river is spanned by two wagon-road bridges and three railroad bridges, none of which are provided with draws; that the region in the vicinity of the river is but thinly settled, the small town of East Chicago containing now about 60 houses, a few ice-houses, and the village of Clarke, a railway watering station of about 100 inhabitants and 30 houses, and a few scattering farm houses at some distance from the bank of the stream, embrace everything in sight.

Although, as stated above, the 9 miles of the river east from Hammond, Ind., furnishes now a good navigable channel of greater capacity than the Calumet River between Hammond and its present mouth, there is practically no navigation on it.

There does not seem to be any present demand for the improvement of this part of the river, except a speculative one by owners of land, desirous of developing towns and attracting an industrial population to points where none now exist.

Whether there will in future be need of its improvement depends upon the influx of population and commercial enterprises, and also upon the completion of the improvement of that portion of the Calumet River between Hammond and its present mouth, now in progress.

In view of these facts it is my opinion that the Grand Calumet River, Indiana, from one-half mile east of Hammond eastward to Lake Michigan, is not at present worthy of improvement by the General Government, and that no public necessity or convenience can be subserved by its improvement.

The act of Congress does not specify the capacity of channel for which estimates are desired. The estimate herewith submitted, based upon the preliminary examination, is for a channel 16 feet in depth and 200 feet in width, the same capacity that part of the river now being improved will have upon the completion of the present project. The estimate also includes an entrance from the lake between parallel piers extending to the 16-foot contour in Lake Michigan.

The estimate is as follows:

Dredging 5,800,000 cubic yards, at 22 cents per yard	$1,276,000
Revetment, 1,600 linear feet, at $16 per foot	25,600
Crib-work, 1,600 linear feet, at $60 per foot	96,000
Total	1,397,600
Add 10 per cent. for contingencies	139,760
Total	1,537,360

An accurate survey of the river would cost (estimated) $1,100, but as the above estimates of quantities are believed to be within 10 per

cent. of what would probably be shown by a detailed survey, it is respectfully recommended that no survey be at present made.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., December 1, 1888.

CAPTAIN: I have the honor to report that in accordance with your instructions I have made an examination of the "Grand Calumet River, Indiana, beginning one-half mile east of Hammond, and thence eastward to Lake Michigan," the result of which is hereby respectfully submitted.

The part of Grand Calumet River located in the State of Indiana consists, like that in Illinois, of an extensive marsh from 600 to 1,400 feet in width with a channel varying in depth and width and widening in a serpentine shape between the banks, which are very irregular in form and elevation, but show a gradual and considerable increase in altitude towards the easterly terminus of the river, where numerous isolated sand hills reach an elevation of probably 100 feet, which for this otherwise very level country is quite noteworthy.

Counting from the steel mill slip half a mile east of the wagon-road bridge at Hammond, and three-fourths of a mile from the State line, and along a direct line about midway between the river-banks, the distance to the old outlet into Lake Michigan is 13¼ miles; but following the winding channel this distance is increased to over 15 miles. The many bends in the channel, causing this difference, increase in number and extent of crookedness towards the easterly terminus.

It is a noteworthy fact that for a distance of nearly 9 miles from Hammond, or to near the Lake Shore and Michigan Southern Railway Bridge, there is a much better channel than that on the lower river from Hammond to Chittenden Bridge.

The stretch referred to has, with the exception of a few short distances, a continuous depth of 10 feet or more (at low-water stage), and along considerable distances, aggregating in length about 3 miles, the bottom was not reached with the 13-foot long sounding pole.

The easterly 5 miles are very irregular in all respects. The depth varies between 1 and 10 feet, with an average hardly exceeding 3 or 4 feet. The channel becomes here generally narrower, with more extensive and irregular bends, occasionally widening out into an open slough; in other places becoming almost extinct to the eye, or only sufficiently wide to push a small skiff through it. Through this part an improved channel would have to be made in a comparatively straight line through the marsh, as it would be impracticable to attempt to follow the original channel.

The north banks consist mainly of bare sand-hills, high and irregular, with scattered pines and here and there patches of heavy underbrush. The south banks are generally also high for this region, but are more regular, and mostly covered with heavier timber and vegetation.

The bottom of the river consists along the whole distance, as far as can be ascertained, of a more or less thick covering of mud and decayed vegetation over strata of sand and clay.

There is at present no navigation east of Hammond, nor is there occasion for any as yet, as there are no enterprises located on this part of the river, except East Chicago, a manufacturing center of quite recent origin, and which will be described in another report.

There are two ice-houses on the south side of the river between this place and Hammond.

Eastward from East Chicago there is only one hamlet (Clarke), located at or near the river, at the crossing of the Pittsburgh, Fort Wayne and Chicago Railroad, 6 miles from Hammond.

This is at present merely a railway water station, with twenty to thirty houses, and, perhaps a hundred inhabitants. It has, however, a post-office, railroad with telegraph station, two large ice-houses belonging to the Washington Ice Company, of Chicago, and one small store with general merchandise.

Besides the South Chicago and Indiana Railway Bridge at Hammond, there are two wagon-road bridges and three railroad bridges crossing the river east of the last-

named town, none of which five bridges is a draw-bridge. Counting their respective distances from the steel-mill slip at Hammond, they are as follow:

(1) *Gibson Wagon-road Bridge*, 2¼ miles east, is a long wooden structure across the marsh, with a narrow opening at the channel large enough to admit a small row-boat.

(2) *Clarke Wagon-road Bridge*, at Clarke, 6 miles from the slip, is a similar structure to the preceding one, with a similar opening at the channel.

(3) *The Pittsburgh, Fort Wayne and Chicago Railway Bridge*, one-half mile further east, is, in fact, an embankment, built across the marsh, with a 40-foot long trestle over the here-contracted channel, by which an opening is made for the passage of smaller boats.

(4) *The Lake Shore and Michigan Southern Railway Bridge*, 8¼ miles from the initial point, is similar to the preceding one, with a 6-foot wide opening through the 60-foot long trestle.

(5) *The Baltimore and Ohio Railway Bridge*, at the tenth mile, is similar to the preceding two; but the embankment, crossing the marsh in a much more acute angle than the others, is much longer, and the abutments for the short trestle are braced by horizontal timbers about 3 feet above the water-level, over which boats must be hauled to pass this place. The channel is very indistinct here and for the greater part of the river eastward.

A map showing the portion of Grand Calumet River under consideration is respectfully submitted herewith. The contours of the river banks, or limits of marsh, as shown on this map, have been obtained from the maps of the original United States surveys under the General Land Department in Washington, D. C. The channel winding between these contours and the depths shown therein are located with sufficient accuracy, from notes and soundings taken at the time of the examination, to give a correct idea of the general character and features of the river.

Such details as railroads, lake system, towns, etc., have been obtained from the best sources accessible.

Very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

JJ 7.

PRELIMINARY EXAMINATION OF A CANAL-WAY CONNECTING THE WATERS OF LAKE MICHIGAN WITH THE CALUMET RIVER BEGINNING AT A POINT ON THE CALUMET RIVER ONE MILE EAST OF HAMMOND, INDIANA, AND RUNNING DUE NORTH TO BERRY LAKE, AND THENCE ALONG THE EASTERN WATERS OF SAID BERRY LAKE; THENCE NORTHEAST TO LAKE MICHIGAN.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., January 3, 1889.

GENERAL: I have the honor to submit, in accordance with the river and harbor act of August 11, 1888, the following report of a preliminary examination of "a canal-way connecting the waters of Lake Michigan with the Calumet River, beginning at a point on the Calumet River 1 mile east of Hammond, Ind., and running due north to Berry Lake, and thence along the eastern waters of said Berry Lake, thence northeast to Lake Michigan; the survey to estimate a canal 14 feet deep and 200 feet wide."

The examination was made under my direction by Assistant G. A. M. Liljencrantz, whose report, with map, is herewith.

From this report it appears that the ground along the proposed canal-way has an average elevation above low water in the river, which is practically the same level as low water in Lake Michigan, of about 5 feet (varying from 3 to 8 feet). The soil is sandy, with scattering small trees, except at Berry Lake, which is a small lake 1¼ miles long by

one-fourth mile wide, of an average depth at the present level of Lake Michigan of about 1 foot, which is probably increased to 3 feet in spring-time and at high stages of water in Lake Michigan. The bottom of the lake is sand and mud, and its area is largely overgrown with marsh grasses, reeds, and sedges. The lake is separated from Lake Michigan by a sandy ridge about one-fourth of a mile wide.

The line of the proposed canal-way is crossed now by five railways and two highways. In addition, it intersects the town-site of East Chicago, where, if the town is developed, additional bridges must be built.

This region is at present but thinly settled. A land company is endeavoring to develop a manufacturing town at East Chicago, where at present some sixty houses have been built, and a number of manufacturing enterprises are under way or contemplated.

The mouth of the proposed canal-way in Lake Michigan is distant only 6 miles from Calumet Harbor, already built by the United States Government, and its junction with the Calumet River is only 13 miles from this harbor via the Calumet River, which is now undergoing improvement by the General Government. The proposed canal is nearly 4 miles in length, and would therefore shorten the distance from its point of junction with the Calumet River to Lake Michigan about 9 miles.

I can not find any public interest that will be subserved by the proposed improvement. It is desired by the parties that own the lands in the vicinity of East Chicago, and are interested in their sale and in the development of industries and population here. The Calumet River after its improvement will furnish adequate water facilities, and it is not considered that the shortening of the distance from East Chicago to the lake of 9 miles, for a small population represented by less than one hundred houses, even if desirable for them, constitutes such a "public necessity" as to require the expenditure by the United States of over $1,000,000.

An accurate survey of this canal-way would cost about $250, but as the examination just made is sufficient for a close approximate estimate of quantities of work to be done in the construction of this canal, no further survey is recommended.

The estimated cost of this canal is as follows:

Dredging 2,954,000 cubic yards, at 25 cents per yard	$738,500
Revetment, 3,000 linear feet, at $16 per foot	48,000
Crib-work, 2,000 linear feet, at $60 per foot	120,000
Five railway bridges, at $30,000 each	150,000
Two highway bridges, at $12,000 each	24,000
Total	1,080,500
Add 10 per cent. for contingencies	108,050
Total	1,188,550

No public interest will be subserved by this improvement, and in my opinion the locality is not at the present time worthy of improvement by the General Government.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., December 3, 1888.

CAPTAIN: I have the honor to report that, in compliance with your orders, I have made an examination of the site for a proposed "canal-way connecting the waters of Lake Michigan with the Calumet River," *via* Berry Lake, Indiana, the result of which is hereby respectfully submitted:

The proposed canal-way commences at the Grand Calumet River, 2 miles east of the Steel Mill Slip at Hammond, and runs due north (on the section line between sections 32 and 33, township 37 north, range 9 west of the second principal meridian) to Berry Lake, a distance of 2 miles; thence in the same direction "along the eastern waters of said Berry Lake; thence northeast of Lake Michigan," a total distance of 3¼ miles.

The ground between the river and Berry Lake has an average elevation of 5 feet above low water in the river, and consists mostly of a sandy soil, with scattered trees of diminutive dimensions, through which a clearing has been partly made by the parties interested in the canal project.

Berry Lake occupies portions of sections 16, 17, 20, and 21, in township 37 north, range 9 west of the second principal meridian. It is from 1¼ to 1½ miles long by about one-fourth mile wide, but with an average depth of only about 1 foot at a low stage of the water-level. The character of the shores indicates that at times there is a rise above this level of fully 2 feet. Such rise is probably occasioned by rain-fall and drains from the adjacent country, which consists of long and sparingly timbered ridges with intervening swamps, and possibly to some extent by the fluctuations of Lake Michigan, with which Berry Lake is indirectly connected through ditches, uniting its waters, *via* the lake system west of it, with the lower portion of Calumet River.

There is at present no direct connection between Lake Michigan and Berry Lake, though it is claimed that at some period in the past such has been the case, when a small creek, Pine Creek, ran from a point at the lower portion of the easterly shore of Berry Lake in a northerly direction, and emptying somewhere north of it into Lake Michigan. The long and narrow swamp found in just about such a position as described seems to verify the assertion.

The northerly portion of Berry Lake has a hard, sandy bottom, free from weeds and bulrushes and with clear water, the low temperature of which, together with the preceding facts, may suggest the possible existence of springs. The middle and southerly portions have layers of soft mud, occasionally from 4 to 5 feet in thickness over the sand, and with sand-bars cropping up here and there above the water surface in the former part; the latter is almost entirely covered with reeds, wild grass, and similar vegetation.

Between Berry Lake and Lake Michigan, a distance of about one-quarter of a mile, the ground is mainly composed of sand, is irregular in form and elevation, which latter varies between 3 and 8 feet above low water in Lake Michigan. This stretch is crossed by three railroads, as accounted for hereafter.

A dredge was found at work at the southerly end of the canal site, which had completed a channel about 40 feet wide, and for a distance of nearly half a mile from Calumet River.

The canal-way, if made, and on the site proposed, will require the construction of five railroad and two wagon-road bridges, as follows: South of Berry Lake, two railroad bridges for the Chicago and Calumet Terminal Railway, and the State Line and Indiana (a branch of the Pittsburgh, Fort Wayne and Chicago) Railway, and one wagon-road bridge for the so-called "Indiana Boulevard," a road running from Sheffield to Gibson Station. North of the lake are the Pittsburgh, Fort Wayne and Chicago (main line), the Lake Shore and Michigan Southern, and the Baltimore and Ohio Railroads, the latter with two tracks, and one wagon road, for which all bridges will be required. The various streets in the, as yet, but partially developed town of East Chicago, will eventually have to be bridged, but nothing definite can be said about these at the present time.

Of the above-named railroads, the State Line and Indiana road is not yet extended across the canal site; but it is in process of construction. The others are built and in use. The main line of the Pittsburgh, Fort Wayne and Chicago Railway has a station at the northerly end of Berry Lake, after which it is named.

Between Grand Calumet River and Berry Lake has lately been established a settlement, or town, which promises in time to become an important manufacturing center if the elaborate plans projected are carried out. It is called East Chicago.

There are some 50 to 60 houses built, and others are under way. A tank factory is in operation; a saw-mill and a railroad repair shop are being built, and a number of other enterprises are contemplated. The proposed canal-way runs about through

the center of this place. The State Line and Indiana Railroad is now running regular passenger trains between Chicago and this place three times daily each way, and is erecting a depot here.

A $6,000 depot is approaching completion for the Chicago and Calumet Terminal road, several streets are graded, and altogether there is exhibited an activity which premises well for the future growth of the locality.

* * * * * * *

A map has been prepared from the best accessible data and from observations made on the ground, and is respectfully submitted with this report.

Two lines of soundings were run, as indicated on the map, showing the general depth of the water in Berry Lake.

* * * * * * *

Very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

J J 8.

PRELIMINARY EXAMINATION OF BERRY LAKE, INDIANA, FORMING A NATURAL HARBOR OF REFUGE.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., January 3, 1889.

GENERAL: I have the honor to submit the following report of a preliminary examination of "Berry Lake, forming a natural harbor of refuge," made in accordance with the river and harbor act of August 11, 1888.

The examination was made under my direction by Assistant G. A. M. Liljencrantz, who reports as follows:

Berry Lake occupies portions of sections 16, 17, 20, and 21, township 37 north, range 9 west of the second principal meridian. It is from 1¼ to 1¾ miles long by one-fourth mile wide, with an average depth of only about 1 foot at a low stage of the water level. The character of the shores indicates that at times there is a rise above this level of fully 2 feet. * * *

There is at present no direct connection between Berry Lake and Lake Michigan, though it is claimed that at one period in the past such has been the case, when a small creek, Pine Creek, ran from a point at the lower portion of the easterly shore of Berry Lake in a northerly direction, and emptying somewhere north of it into Lake Michigan.

The northerly portion of Berry Lake has a hard sandy bottom, free from weeds and bulrushes, and with clear water, the low temperature of which, together with the preceding facts, may suggest the possible existence of springs. The middle and southern portions have layers of soft mud occasionally from 4 to 5 feet in thickness over the sand. The southerly portion is almost entirely covered with weeds, wild grass, and similar vegation.

Between Berry Lake and Lake Michigan, a distance of about one quarter of a mile, the ground is mainly composed of sand, is irregular in form and elevation, which latter varies between 3 and 8 feet above low water in Lake Michigan. This stretch is crossed by three railroads.

The act requires a report upon "Berry Lake, forming a natural harbor of refuge." A pond covering an area of about 250 acres, separated from all waters upon which navigation exists, can not be considered as meeting the requirements of a "natural harbor of refuge," even if its slight depth did not prevent all navigation whatever upon it. It is only a little pond in the interior of Indiana, a "natural harbor of refuge" for aquatic birds only.

It can not be seen how the United States can "form" a "natural harbor of refuge" by the expenditure of any amount of money, or can improve a "natural harbor of refuge" where no harbor whatever exists as a basis of improvement.

No public interests can be at present subserved by improving Berry Lake, and the locality in my opinion is not now worthy of improvement by the General Government.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

J J 9.

PRELIMINARY EXAMINATION OF GRAND CALUMET RIVER, ILLINOIS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., February 23, 1889.

GENERAL: With reference to the survey of the "Grand Calumet River Illinois," ordered by the river and harbor act of August 11, 1888, I have the honor to report as follows:

The portion of the Grand Calumet River in question lies between Hammond, Ind., which is on the border of the two States, and Calumet Harbor, a distance of about 12 miles. It has already been surveyed, and work is contracted for under this same act of Congress.

A survey of the lower portion of this stretch, viz: From the "Forks" to the mouth, was made under direction of Major Lydecker, Corps of Engineers, in 1881–'82 (see Report Chief of Engineers, 1882, page 2247). Congress, acting upon the recommendations in this report, in the river and harbor act of August 2, 1882, required a Board of Engineers to establish dock lines; to define the channel from the mouth to the forks of the Calumet; to make estimates of cost, and to inform Congress what legislation is necessary. The report of this Board, dated October 6, 1882, is published in the Annual Report of the Chief of Engineers, 1883, page 1748.

They established dock lines and submitted a project and estimates for a channel 200 feet wide and 16 feet deep from the mouth of the Grand Calumet River to the Forks. This project required 2,500,000 cubic yards dredging.

From the Forks to one-half mile east of Hammond, Ind., all of which stretch lies within the State of Illinois except 1 mile, the Grand Calumet was surveyed under direction of Maj. W. H. H. Benyaurd in 1884, and reported upon by Maj. T. H. Handbury, Corps of Engineers, March 27, 1885 (Report Chief of Engineers, 1885, page 2059).

Major Handbury submitted a project and estimate for a channel of the same capacity as that recommended by the Board of Engineers for the lower part of the river. This project also required 2,500,000 cubic yards dredging.

Both these surveys were elaborate and accurate. The maps were forwarded to the Department, and Congress by making appropriations in the last three river and harbor acts has undertaken the improvement of the river under the project submitted. It will be seen by referring to the reports mentioned that no separate estimates were made

for the portions of the river within the limits of the States of Indiana and Illinois respectively.

Of the 5,000,000 cubic yards of dredging required under these projects now in course of execution under the river and harbor acts of July 5, 1884, August 5, 1886, and August 11, 1888, 474,566 cubic yards dredging is required within the limits of the State of Indiana, and the remainder, 4,525,434 cubic yards, within the limits of the State of Illinois. The cost of this work will depend upon prices secured after public advertisement, if done by contract. The cost will probably not exceed 20 cents per cubic yard, which would make the work cost not exceeding—

In Illinois	$905,086.80
In Indiana	94,913.20
Total	1,000,000.00

The cost has been estimated as low as 5 cents per cubic yard, not including cost of plant, if done by dredges owned and operated by the United States, but my experience does not make me believe that the United States should undertake definite work, the difficulties of execution of which can clearly be foreseen and estimated either as a matter of economy or advantage over the contract system.

I can not discover that any greater channel capacity than projected is demanded by any interest upon the Calumet River. The region is rapidly settling up, and new enterprises based upon the navigation of the stream are constantly being undertaken. There is a demand for a practicable channel 16 feet in depth, with occasional turning basins, irrespective of the ultimate width. Such a channel would form part of the adopted project, and the improvement, if not limited in location and extent by Congress, could be made progressive throughout the portion of the river in question with great benefit to the interests of this region, *i. e.*, by first making a practicable channel of proper depth throughout, then widening it to the full limits, as appropriations are subsequently made; the comparative cost of which practicable channel would be nearly proportional to its width.

It appears from the foregoing facts that no further examination or survey of the Grand Calumet River in Illinois is required or advisable, all necessary data for an estimate of cost of an improvement of any character having been already submitted to Congress, or attainable.

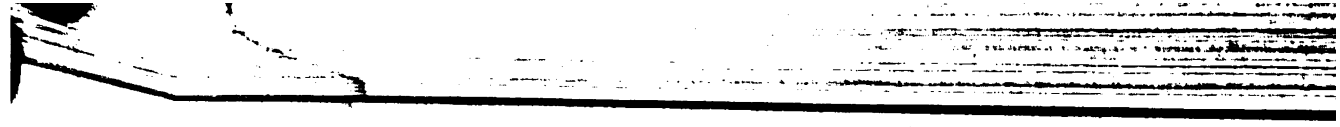
As this river and lakes connected with it form a valuable system of navigation well worthy of full improvement by the Government, and may possibly at no distant day become part of a through route via the Illinois River from the lakes to the Mississippi, the interests of the public in the navigation of the system should be carefully guarded by appropriate legislation. In my opinion, in addition to the legislation recommended by the Board of Engineers in 1882, no bridges should be allowed with a less draw span than 80 feet perpendicular to the channel axis, over any part of the Grand Calumet River below the Forks, or over the Little Calumet River below Blue Island.

A small map showing the Calumet River system is herewith.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.



APPENDIX K K.

IMPROVEMENT OF RIVERS AND HARBORS ON THE EASTERN SHORE OF LAKE MICHIGAN.

REPORT OF MAJOR WILLIAM LUDLOW, CORPS OF ENGINEERS, BVT. LIEUT. COL. U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

IMPROVEMENTS.

1. Charlevoix Harbor and entrance to Pine Lake, Michigan.
2. Frankfort Harbor, Michigan.
3. Harbor of Refuge at Portage Lake, Michigan.
4. Manistee Harbor, Michigan.
5. Ludington Harbor, Michigan.
6. Pent Water Harbor, Michigan.
7. White River Harbor, Michigan.
8. Muskegon Harbor, Michigan.
9. Grand Haven Harbor, Michigan.
10. Black Lake Harbor, Michigan.
11. Saugatuck Harbor, Michigan.
12. South Haven Harbor, Michigan.
13. St. Joseph Harbor, Michigan.
14. St. Joseph River, Michigan.
15. Michigan City Harbor, Indiana.

EXAMINATIONS.

16. Saugatuck Harbor, Michigan, to obtain channel of navigable width with a minimum depth of 15 feet, and reconstructing piers.
17. Grand River, Michigan, from Grand Rapids to Lake Michigan, for channel of navigable width, minimum depth of 10 feet.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 1, 1889.

SIR: I have the honor to submit herewith the annual reports relating to the works of river and harbor improvements under my charge for the fiscal year ending June 30, 1889.

Very respectfully, your obedient servant,

WILLIAM LUDLOW,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

GENERAL REMARKS.

There are some considerations relative to the construction and regulation of the harbors on the east shore of Lake Michigan, which are of importance as affecting the methods and details of construction, and the provision for their maintenance and protection.

(1) The coast is characteristically a sandy one. Enormous dunes occupy the foreshore, and the beach and bed of the lake are of the same material. The sand is fine, and easily set in motion by a moderate movement either of wind or water, and during the gales that occur with frequency and violence, the quantities of sand transported along the coast are beyond the possibility of computation. Here, then, is an active, unwearying force, perpetually at work to close an entrance or construct a bar, and the history of the harbors in question is almost one of constant, and sometimes futile, endeavor to counteract the destroying agencies opposing their construction.

(2) In the majority of cases, the streams discharging into the lake are of small volume and capacity, and in consequence have little power to contend with the natural forces seeking to obstruct their mouths, even with all the aid afforded by bank and channel revetments and piers projecting into the lake to guide the current and protect it from wave action. In many cases harbors have been made simply by cutting channels through the sand beach, separating an inner lake, small or large, from Lake Michigan, and in such there is no current to aid in maintaining the channel, or one that may oscillate to and fro according to the varying level of the two bodies of water.

(3) The great lakes have no uniform level, as has the sea. They rise and fall suddenly, often with contracted areas of high and low barometer, and gradually with more general meteorological conditions controlling rainfall and evaporation.

The lake level, at different periods, has ranged 3 feet and more below, and as much above, its average plane, and as these periods may extend over several years, the depth of a channel at one time sufficient will be quite inadequate at another, or even in the year following; and this without any change in its bed.

It follows from these facts:

First. That the movement and inflow of sand is an active and opposing agency that must invariably be taken into account and guarded against as completely as possible.

Second. That since the precautions in this direction, no matter how elaborate, must not close the entrance, and can not absolutely prevent the blowing of sand and the inwashing of silt, a constant feature of the construction and maintenance of these harbors must be the service of a dredge, to keep their depths such as to meet the requirements of navigation and to open them in the spring, and at such times as the enforced cessation of work in the winter or the effects of a storm shall have reduced the channel capacity.

Piers and training-walls alone, no matter how extended, can not of themselves make or maintain navigation. Where there is no current the dredge is the sole reliance, after all precautions have been taken to reduce the total amount of work that it must perform. Where there is a large outflowing volume and a powerful current, as at Grand Haven, the stream is the dredge, and if the piers at the mouth are prolonged to a sufficient depth in the lake, the entrance can be maintained with but little aid of the artificial dredge.

The estimates for the ensuing fiscal year, it will be observed, seek to make provision for this imperative need. They cover the construction of sand defenses where needed, and of sheet-piling the present partly open and permeable piers and revetments, and in addition the procurement of sufficient dredging plant to keep the harbors open, as the only satisfactory and most economical means.

At the present time there are two dredges operated by the United

States, but the one at Michigan City belonged to that place and has nearly constant work. It is therefore almost a fixture at that harbor, leaving but one dredge of limited capacity, a tug, and two dump-scows constituting a dredging plant for the service of the remaining 13 harbors distributed along 250 miles of lake coast from St. Joseph to Charlevoix. At the opening of navigation nearly every one of these imperatively demands dredging to permit vessels to move. The calls are often made again during the summer and again in the fall. The task is manifestly a hopeless one for one dredge to accomplish, as from two to six weeks' work is required at every visit. Recourse is therefore had to contracts, and all prices have to be paid, as during the season a dredge can earn $100 a day at private work and will not throw away its time for less. The Government dredging costs between 9 and 15 cents per cubic yard, depending on the locality. The contract prices range as high as 90 cents and $1.

For these reasons, and because the objective point after all of the Government expenditures is the satisfactory and economical maintenance of such navigation as the business of a harbor demands, the proposition is to divide the harbor district into four dredging subdistricts, with a dredging plant for the service of each. Michigan City Harbor is one of these, and nearly constant work is needful. It has its dredge and scows, and needs a tug. St. Joseph, South Haven, Saugatuck, Black Lake, and Grand Haven make the second district; Muskegon, White River, Pentwater, and Ludington, the third; and Manistee, Portage Lake, Frankfort, and Charlevoix, the fourth.

This arrangement of the plant will permit of about two months' work at each harbor during a season of eight months, and admit of dispensing with costly contract dredging, with adequate maintenance at all times of channel depths.

The estimates for 1891 in each case make provision for a due fraction of the cost of a plant, estimated as follows:

For a dredge of 600 or 700 yards daily capacity	$14,000
For a tug to tow the scows for dumping, and conduct the outfit safely from harbor to harbor	9,000
For two dump-scows, each of 70 yards capacity	3,000
Total cost	26,000

The rapid movement of large vessels, or of small ones even, in a narrow revetted channel, has a very injurious effect upon the bank protection. A wave is projected in front, and the subsequent reaction upon passage of the vessel reduces the level as much below the normal with a sucking action that tends to pull out the revetment, and fitting legislation upon this subject, authorizing the Secretary of War to make and enforce due regulations in this regard, as has been done in some instances, notably the St. Clair Flats Channel, seems the simplest remedy.

Legislation seems needful also to protect the piers and revetments from destruction by fire. These structures are of wood, and from exposure to the summer sun become as dry as tinder and as inflammable. The smaller vessels, such as tugs, etc., at many of the lumber districts burn slabs, and the exhaust from the stack throws out lumps of fire unless wire cages surmount the stack and prevent it. At numerous harbors the frequency of these fires is attested by the number of burned places, some of them of considerable extent, and in one case the lightkeeper stated that at times he and the crew of the life-saving station were kept busy putting them out. Some of the more important towns,

such as Ludington, have, in their own interest, made local regulations to control the matter, but in the more numerous cases there is no regulation nor hope of any. The remedy seems to be in a general enactment, made enforceable by the local Federal authorities.

KK r.

IMPROVEMENT OF CHARLEVOIX HARBOR AND ENTRANCE TO PINE LAKE, MICHIGAN.

The project of 1868, revised in 1875 and 1876, was to open a straight channel from Round Lake into Lake Michigan, from 100 feet to 150 feet in width and 12 feet deep, protecting the lake entrance with piers and the sides of the cut with close piling. In 1882 the project was enlarged to extend the 12-foot channel through from Round Lake to Pine Lake, 83 feet wide, and protect the banks with pile revetments. The north pier extends 800 feet into the lake, terminating in about 14 feet of water. This portion is crib-work, from 16 feet to 20 feet wide, some of which, originally built under direction of the local authorities, is very irregular. The shore protection is about 900 feet of what is termed "plank-beam" revetment, consisting of two open lines of piles about a foot apart, with boards and plank piled longitudinally between them. This will eventually have to be replaced with a better type of revetment.

The south pier has about 300 feet of crib-work in the lake, with but 8 or 9 feet of water at its outer end. The south-shore revetment is some 1,500 feet long, of pile and "plank beam," which is much decayed, and must presently be replaced.

In the "upper channel," connecting Round and Pine lakes, the sides are protected by pile revetments about 350 feet in length. The sand drifts into the channel and the revetment must be sheet-piled to make it tight, and the north revetment must be continued about 200 feet, so as to close the old crooked channel which now causes an eddy and deposits in the cut.

The old irregular crib-work of the north pier was sunk on the natural bottom, without piling or enrockment, so that it has been dangerous to dredge in its vicinity. This portion of the pier will require rebuilding in order that the channel width and depth can be obtained with safety. The south pier has an insufficient extension, as the littoral drift and wave resultant tend to the accumulation of sand against it.

Contract was made in February, 1889, for the construction of three additional cribs, 50 by 20 by 18½ feet, on stone foundation, which will extend the pier into 12 feet of water, leaving two more 50-foot cribs to be built to complete the existing project. On June 30, 1889, the three cribs had been built to a height of ten courses of timber, and preparations were making to sink them on their sites. Repairs were also making to the end crib of the north pier, which had been badly damaged either by ice or a collision. Between July 17 and August 3, 1888, the Government dredge took out 2,500 yards of sand between the piers, making a narrow 12-foot channel. Dredging was again required in the spring of 1889 and advertised for, but the price asked (24 cents) was considered too high, the bids rejected, and the work is now under way with the Government dredge.

At Charlevoix, as at most of the lake harbors, there is a constantly recurring necessity for dredging to obtain adequate depth in the channel.

In fact, it may be said that the dredging is the main feature and the pier and revetment works are but necessary adjuncts. The drainage area which discharges its surplus waters at Charlevoix is some 50 miles square in extent, but Pine Lake is a large body of water and a considerable rain-fall raises the surface to but a moderate amount. While in general there is a gradual movement towards Lake Michigan, and therefore an outward current in the channel, this is frequently checked and often reversed by those sudden elevations of the lake surface that constitute so marked and peculiar a feature of the Great Lakes. A rise of 1 to 2 or even 3 feet has been observed, reversing an outflowing current of 1 or 2 miles an hour with considerable violence, and as suddenly subsiding. It may be said, therefore, that but little effective aid can be derived from the discharge of the rain-fall to aid in maintaining the channel depth, and this effect would in any case cease at the end of the piers where the lake is reached.

With the $3,200 of balance July 1, 1889, it is proposed to deck the north pier and to revet across the old channel between Round and Pine lakes, reserving about $1,200 for dredging and urgent repairs.

During the fiscal year 1890–'91, the revetment of the upper channel between Round and Pine lakes should be sheet-piled to keep the sand from coming in at an estimated cost of $1,200; and the south revetment of the "lower" or entrance channel should be rebuilt with a regular sheet, pile structure at a cost of $9,600.

Charlevoix, with Frankfort, Portage Lake, and Manistee, constitute the proposed fourth dredging district, the purpose and details of which are more specifically set forth elsewhere in this report.

The dredging outfit consists of a dredge, tug, two dump scows, at an estimated cost of $26,000, one-fourth of which, $6,500, should be paid by Charlevoix. The operating expenses of the plant for two months will be about $2,100 in addition. The total estimate for Charlevoix for 1891, with allowance for contingencies, is therefore $22,000.

The building of the two additional 50-foot cribs on the south pier should be deferred until the work above indicated has been provided for.

The Light-House Establishment maintains a fifth-order light on the north pier-head.

A public draw-bridge, with pivot-pier and two 50-foot openings, of which the south is the channel, crosses the entrance at the inner throat of the harbor, adjoining Round Lake. The bridge is operated by hand lever.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1868, as amended in 1876	$186,000.00
Whole amount appropriated from 1868 to 1889, inclusive	93,500.00
Whole amount expended	80,817.74

Money statement.

July 1, 1888, amount available		$2,920.80
Amount appropriated by act of August 11, 1888		12,500.00
		15,420.80
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$2,171.69	
July 1, 1889, outstanding liabilities	558.85	
July 1, 1889, amount covered by existing contracts	8,595.30	
		11,325.84
July 1, 1889, balance available		4,094.96

Amount (estimated) required for completion of existing project	$92,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	22,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for improving harbor at Charlevoix, Mich., received and opened December 22, 1888.

	1. Hiero B. Herr & Co.	2. George W. Crouter.*	3. Truman & Cooper.	4. Fred. J. Meech.
Timber:				
Oak.....per 1,000 feet, B. M..	$50.00	$25.00	$50.00	$40.00
Hemlock.....do....	22.00	15.00	18.00	17.00
Pine.....do....	26.00	24.00	23.00	25.00
Plank, pine.....do....	22.00	24.00	14.60	25.00
Iron:				
Nuts, screw and washer bolts..per pound.	.07	.07	.05	.05
Drift-bolts.....do....	.06	.06	.05	.04
Wrought spikes.....do....	.07	.07	.05	.05
Stone.....per cord..	10.00	9.00	10.00	9.00
Brush.....do....	5.00	5.00	5.00	6.00
Dredging foundation.....per cubic yard..	1.50	.90	.90	1.00
Total for one crib	3,476.59	2,865.10	2,990.96	2,883.36
Total for three cribs	10,429.77	8,595.30	8,972.88	8,650.08

*Contract entered into February 12, 1889.

COMMERCIAL STATISTICS, CHARLEVOIX HARBOR, MICHIGAN.

Vessels entered and cleared, 1884 *to* 1888.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	772	$335.46	.....
1885	599	779.53	.....
1886	674	390.46	.....
1887	753	.....	151,388
Calendar year 1888	526	.....	92,386

Articles entered and cleared, 1888.*

Articles.	Quantities.	Articles.	Quantities.
Entered:		Cleared—continued.	
Merchandise.....tons..	4,000	Hoops.....number..	5,550,000
Iron ore.....do....	25,000	Broom-handles.....do....	65,000
Coal.....do....	3,000	Railroad ties.....do....	108,000
Grain.....bushels..	65,000	Cedar posts.....do....	112,000
Feed.....tons..	700	Wood.....cords..	5,000
Lime.....barrels..	1,500	Slabs.....do....	2,000
Kerosene.....do....	1,000	Hemlock bark.....do....	12,000
Beer.....do....	400	Merchandise.....tons..	8,000
Brick.....number..	50,000	Chair stuff.....feet..	20,000
Limestone.....tons..	1,100	Pig-iron.....tons..	15,000
Cleared:		Potatoes.....bushels..	7,000
Lumber.....feet, B. M..	18,000,000	Fish.....pounds..	500,000
Shingles.....number..	14,000,000	Apples.....bushels..	2,000

*Compiled from a statement furnished by Mr. J. Milo Eaton, deputy collctor.

K K 2.

IMPROVEMENT OF FRANKFORT HARBOR, MICHIGAN.

'he original project of 1866 was to connect Lake Aux Becs Scies h Lake Michigan by cutting a 12-foot channel 200 feet in width ough the narrow beach separating them, reveting the cut, and pro- ting the entrance by piers. In 1881 this project was modified to ex- d the piers to rocky bottom in 16 feet in Lake Michigan, with the w of avoiding further shoaling from outside.

'he north pier now has a projection beyond the shore of 400 feet, l a total length, including the crib-work and revetment, of 1,000 feet. outer pier still lacks 400 feet of the full extension, of which 100 will be built this season. The south pier projects 1,050 feet, has a al length of 1,350 feet, including shore revetment. It lacks 2 cribs) feet) at the outer end.

'he works generally are in good condition, but the south pier needs an average about 3 feet of stone filling. Sand fences are needed at beach-line on both piers, the sand drifting particularly over the th pier.

'ontract was made in February, 1889, for the construction of two 50 24 by 22½ feet cribs on pile foundations in extension of the north . Work began in May, 1889. By June 30, one crib had been ed, and the other was built to the thirteenth course. As soon as prac- ble after the opening of navigation in 1889, and other work had n disposed of, the Government dredge was taken to Frankfort and pened the channel from 10½ to 13 feet by a cut 25 feet in width.

f the balance of $1,700 remaining June 30, 1889, it is proposed to end about $700 in the construction of sand fences to prevent the ng of the channel over the pier, and to hold the remainder until spring of 1890, when further dredging and other work will be ded.

or the year ending June 30, 1891, provision should be made to con- ct three of the remaining six cribs of the north pier at an estimated of $20,000, and to fill the south pier with stone at a cost of $1,000. nkfort is in the dredging district with Charlevoix, Portage Lake, and nistee, and should pay for one-fourth of the cost of a dredging- t, $6,500, and for two months' work, $2,100. These items, with 15 cent. added for contingencies, make the total amount required for fiscal year 1890–'91, $34,000.

e Light-House Establishment maintains a sixth-order light near the end of the h pier, and the Life-Saving Service a station at the inner end.

is work is located in the Michigan collection district, Michigan. The nearest of entry is Grand Haven.

inal estimated cost of work in 1866, as amended in 1868 and 1879...	$278,436.28
le amount appropriated from 1866 to 1889, inclusive.....	263,659.85
unt covered into the Treasury, Report 1871, page 133.....	5,721.50
le amount expended	247,932.32

Money statement.

1, 1888, amount available		$3,319.93
nnt appropriated by act of August 11, 1888.....		8,000.00
		11,319.93
1, 1889, amount expended during fiscal year, exclusive of bilities outstanding July 1, 1888.....	$612.26	
1, 1889, outstanding liabilities.....	701.64	
1, 1889, amount covered by existing contracts.....	8,081.58	
		9,395.48
1, 1889, balance available		1,923.45

Amount (estimated) required for completion of existing project	$20,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1891	34,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposal for improving harbor at Frankfort, Mich., received and opened December 22, 1888.

	1. Hiero B. Herr & Co.	2. John Munro, jr.	3. Truman & Cooper.*
Piles:			
Foundation.....per linear foot..	$1.50	$0.95	$0.89
Sheet.....do....	.40	.67	.39
Timber:			
Oak.....per M feet, B. M..	40.00	40.00	44.00
Hemlock.....do....	22.00	18.00	20.00
Pine.....do....	26.00	25.00	24.00
Pine plank.....do....	20.00	24.00	20.00
Iron:			
Nuts, screw and washer bolts.....per pound..	.06	.05	.05
Drift bolts and straps.....do....	.05	.04½	.04
Wrought spikes.....do....	.06	.06	.04
Stone.....per cord..	10.00	10.50	8.00
Brush.....do....	5.00	5.00	5.00
Dredging foundation.....per cubic yard..	1.50	.98	.89
Total for one crib	5,136.62	4,701.05	4,044.79
Total for two cribs	10,273.24	9,402.10	8,081.58

* Contract entered into February 25, 1889.

COMMERCIAL STATISTICS OF BRANKFORT HARBOR, MICHIGAN.

Vessels entered and cleared.

Years.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	498	$404.70	.....
1885	261	75.66	.....
1886, 1887, 1888	(*)	(*)	.....
Calendar year 1888	1,342	.....	216,376

* Not stated.

K K 3.

IMPROVEMENT OF HARBOR OF REFUGE AT PORTAGE LAKE, MICHIGAN.

The original purpose of this work, as set forth in the project of 1879, was to secure an entrance from Lake Michigan into Portage Lake, with a depth of 18 feet and a width greater than that usually adopted, in order that it should serve not only local needs, but as a harbor of refuge for the general commerce of the lake. The piers were to reach approximately to the 18-foot contour and connect with the deep water in Portage Lake. As so far constructed, the north pier has a projection of 650 feet to about 13 feet of water, and the south pier about 500 feet, ending in 7 or 8 feet of water. The shore revetments between the lakes are respectively 800 feet on the north and 900 feet on the south side. The

width between piers is 370 feet, and the channel depth ranges from 6½ to 9 feet near the north pier. The north pier lacks 400 feet of the extension originally proposed and the south pier 700 feet. The wide opening between the piers has never been completely dredged, and is choked with accumulations which are yearly added to by sand driven in from the lake and over and through the piers. These are now, from lapse of time, in a condition calling for partial reconstruction. The outer 150 feet of the north pier are in good shape, but this is really the only sound and serviceable part of the work.

The paucity of the annual appropriations towards the completion of so considerable an undertaking has made it impossible to attain any such results as were contemplated, and brought the history of the work to a point where a general reconstruction of the greater part of it must be considered. The local commerce of the harbor is at this time small and its requirements as to depth and width of channel moderate. It becomes a question whether the original project shall be adhered to or a judicious modification of it made, involving a reduction in the projected depth and width of opening, and consequent reduction in the total cost of completion.

In accordance with the original plan, which would still call for an expenditure of $165,000 or $170,000, the engineers in charge have recommended appropriations of $100,000 or $150,000, for which Congress has allotted $10,000. In view of these facts, it seems scarcely worth while to continue estimating for the larger sums, and it would seem better to reduce the scale of the project to one of such extent as may reasonably hope for completion during the present generation, and thereafter be maintained by moderate annual allotments for dredging and repairs.

A 10-foot or 12-foot channel, with an entrance 150 to 200 feet wide, reliably maintained, would be of some value, while the present wide and shallow entrance between the uncompleted piers, rotting down from age and exposure, answers neither existing nor future requirements. In any case annual allotments for dredging will be needful.

There is practically no current through the entrance other than the oscillations due to the varying level of the bodies of water which it connects. The piers of themselves will not furnish depth; they can but protect the channel from excessive incursions. The natural action of the wind and waves is to force sand into the entrance, and this can only be removed by the frequent service of a dredge.

The total expenditures to June 30, 1889, for construction, dredging, and repairs, amounts to $83,959.95. During the year just closed the channel was dredged in June and July, 1888, cutting a 10-foot channel 40 feet wide. With the appropriation of $10,000 of August 11, 1888, contract was made to remove 60,000 yards, with a maximum depth of 12 feet. Work began May 7, 1889, and up to June 30, 23,000 yards had been dredged and dumped in the outer lake.

With the balance of $8,600 it is proposed to continue the dredging to the amount of $5,000 or $6,000, and hold the remaining $3,000 or $2,000 for further dredging in the spring of 1890 and such repairs as may be most urgent.

For the year ending June 30, 1891, it is important to provide for necessary repairs for the entire north pier shoreward of the outer 150 feet. The total length of the portion to be repaired is 1,220 feet, which can be sheet-piled on one side for about $6,000. Sand fences, to prevent drifting from beach and hills, will cost $500.

Dredging is the present main requirement at Portage Lake. It is in the dredging district with Charlevoix, Frankfort, and Manistee, and

should pay a fourth of the cost of the dredging outf
months' dredging will cost $4,200. These items, wit
for contingencies, make the total amount required f
$20,600.

The entire south pier needs rebuilding and an ex
or 300 feet if 10 or 12 feet of water is desired. Thi
ent estimated for, since a decision should be mad
existing project is to be carried out or modified.
width and depth, the south pier can be moved nor
200 feet distant from the north pier.

The work is located in the Michigan collection district,
port of entry is Grand Haven, Mich. The nearest light-hou

Original estimated cost of work, 1879.....
Whole amount appropriated from 1879 to 1889, inclusive ....
Whole amount expended .....

Money statement.

July 1, 1888, amount available.....
Amount appropriated by act of August 11, 1888 .....

July 1, 1889, amount expended during fiscal year, exclusive
liabilities outstanding July 1, 1888.....
July 1, 1889, outstanding liabilities.....
July 1, 1889, amount covered by existing contracts.....

July 1, 1889, balance available.....

Amount (estimated) required for completion of existing pr
Amount that can be profitably expended in fiscal year ending
Submitted in compliance with requirements of sections 2
harbor acts of 1866 and 1867.

Abstract of proposals for dredging at harbor of refuge at Por
opened December 22, 1888.

No.	Name of bidder.
1	William T. Casgrain .....
2	Christopher H. Starke .....
3	Samuel O. Dixon .....
4	Truman & Cooper* .....
5	White & Finch .....

*Contract entered into February 25, 1889.

COMMERCIAL STATISTICS HARBOR OF REFUGE AT PORT

Vessels entered and cleared.

Fiscal and calendar years.	
Fiscal year 1887.....	
Fiscal year 1888.....	
Calendar year 1888.....	

K K 4.

IMPROVEMENT OF MANISTEE HARBOR, MICHIGAN.

The project of 1866, modified in 1870, 1874, was designed to secure a channel 12 feet deep at the mouth of the Manistee River with piers projecting to the 14-foot curve in Lake Michigan. The Manistee River has a drainage area of some 1,600 square miles and a serviceable outflowing current into the lake. The north pier projects 750 feet from shore and needs 200 feet to complete it. The south pier has about the same projection, but needs 300 feet for completion. The width between the piers is 180 feet, and the channel between them is good for 14 feet with 11½ feet in the river above the piers. Some 300 feet or 400 feet outside the entrance is a shoal with about 12 feet upon it, but 13 and 14 feet can be carried in.

The piers are in fair condition, needing filling and decking. The outer crib of the north pier is in need of repairs. The pile revetment in continuation of the north pier, 1,100 feet, is in a dilapidated condition with rotten faces and ties, and needs rebuilding above the water. The south pile revetment, 500 feet, has about disappeared, its place having been taken by a slab revetment and piles of lumber belonging to the company occupying the land. During the past fiscal year contract was made for the construction of two 50 by 30 feet cribs on the south pier. Work began in May, 1889, and by June 30 both cribs had been built to the fourteenth course.

The expenditures for the fiscal year 1888–'89 were nominal, with the exception of $500 part payment for the survey steamer, procured in May last for the general service of the harbors on the east shore of Lake Michigan, and paid for from those balances which were best able to furnish the amount required.

With the balance of $6,800 available on June 30, 1889, it is proposed to repair the outer crib of the north pier and put on 700 feet of decking, also to supply stone filling to south pier, these items costing about $1,670; to dredge between the piers and in the river above to the extent of $1,000, and with the remaining $4,000 begin the reconstruction of the north pile revetment by cutting down the decayed superstructure and building up with a timber-face and sheet piling.

As the present available channel depth is in excess of the draught that can be carried to the town, about 1¼ miles inland on Manistee Lake, there seems no present necessity for extending the piers, and it will be preferable to put the existing constructions in thorough repair and make provision for dredging the channel through to the lake to the requisite depth.

For the year ending June 30, 1891, appropriations should be made for the following items: For the completion of repairs to the north pier revetment, $7,500; one-fourth the cost of a dredging plant for the fourth district, $6,500; two months' dredging, $2,100. The sum of these items is $16,100, and with 20 per cent. for contingencies the amount required for the year ending June 30, 1891 is $19,400.

While this amount is considerably in excess of the usual appropriation, it is proper to say that Manistee is one of the largest and most important shipping points in the district, and the amounts needed to keep the horbor works in repair and to carry the improved channel to connect with Manistee Lake are small compared with the commercial interests involved.

The light-house establishment maintains a sixth-order light on the south pier, and the Life-Saving Service has a station near the inner end of the north pier.

This work is located in the Michigan collection district, Mich
of entry is Grand Haven, Mich.

Original estimated cost of works, 1866, as amended in 1871, 187
Whole amount of appropriations 1866 to 1889 inclusive.....
Whole amount expended.....

Money statement.

July 1, 1888, amount available.....
Amount appropriated by act of August 11, 1888.....

July 1, 1889, amount expended during fiscal year, exclusive o
liabilities outstanding July 1, 1888.....
July 1, 1889, outstanding liabilities.....
July 1, 1889, amount covered by existing contracts.....

July 1, 1889, balance available .....

Amount (estimated) required for completion of existing proj
Amount that can be profitably expended in fiscal year ending J
Submitted in compliance with requirements of sections 2
harbor acts of 1866 and 1867.

Abstract of proposals for improving harbor at Manistee, Mich.,
cember 22, 1888.

	1. Truman & Cooper.	
Piles :		
Foundation.....per linear foot..	$0.80	
Sheet.....do....	.26	
Timber :		
Oak.....per M feet, B. M..	40.00	
Hemlock.....do....	18.00	
Pine.....do....	23.60	
Plank, pine.....do....	14.00	
Iron :		
Nuts, screw and washer bolts.....per pound..	.05	
Drift bolts and straps.....do....	.04	
Wrought spikes.....do....	.04	
Stone.....per cord..	8.00	
Brush.....do....	4.00	
Dredging foundation.....per cubic yard..	.70	
Total for one crib.....	4,736.45	
Total for two cribs.....	9,472.90	

* Contract entered into February 26, 1889.

COMMERCIAL STATISTICS, MANISTEE HARBOR, M

Vessels entered and cleared.

Years.	Num
Fiscal year—	
1884.....	
1885.....	
1886.....	
1887.....	
1888.....	
Calendar year 1888.....	

Value of imports and exports.

Domestic imports, 1888	$1,522,164.00
Domestic exports, 1888	5,744,388.14
Foreign exports, 1888	143,750.00

Number of vessels entered and cleared.

Entered from domestic ports, 1888	1,794
Cleared for domestic ports, 1888	1,782
Cleared for foreign ports, 1888	19

*Articles entered and cleared, 1888.**

Articles.	Quantities.	Articles.	Quantities.
Entered:		Cleared:	
Coal ..... tons..	5,223	Lumber ..... feet, B. M..	292,875,000
Merchandise ..... do....	8,135	Merchandise ..... tons..	1,042

*From a statement furnished by Mr. W. B. McPherson, deputy collector.

K K 5.

IMPROVEMENT OF LUDINGTON HARBOR, MICHIGAN.

Prior to the improvement of the entrance by the United States, a narrow channel of about 7 feet depth had been made between Lake Michigan and Pere Marquette Lake, by revetting the banks of the natural outlet with slabs.

The project of 1867 was designed to increase the depth to 12 feet and widen the entrance to about 200 feet. The project of 1885 proposes to widen the entrance to 400 feet and increase the depth to 18 feet, and thus create a "harbor of refuge" for the benefit of the general commerce. The fulfillment of this project would require the removal of the present south pier and the construction of a new one, 400 feet distant from the north pier, to which it has been objected that the freer run of the sea from the lake into the inner harbor in Pere Marquette Lake would injure the existing wharves and loading facilities. There is much weight in this objection and it is probable that so much of the general results sought as are practicable can be secured, without interference with local constructions and interests, by substituting for the reconstruction of the south pier the provisional arrangement authorized in December, 1888, by which the new south pier is to begin opposite the outer end of the present south pier, and the interval be closed by a pile and stone wing.

As the works now stand, the north pier has a total length of 950 feet, projects 600 feet beyond the shore-line, and terminates in about 15 feet of water, with 11 and 12 feet soundings 250 feet further out in the lake. The south pier has a total length of 1,100 feet, with 500 or 600 feet of shore revetment in continuation. It projects into the lake about 650 feet, and ends in 21 or 22 feet of water, with 17½ feet a hundred yards further out. The channel depths between the piers vary from 13 feet to 16 feet. The drainage area of Ludington is only about 50 square miles, and there is practically no useful current in the entrance. Dredging has to be resorted to from time to time to hold the present depth, and an increase can only be had and maintained by the service of a

dredge. During the past year the strip of land adjacent to the south pier upon which it has been proposed to build the new south pier was transferred to the United States.

Under the provisional arrangement of December, 1888, above referred to, contract was made for the construction of ten new cribs 24 by 50 feet on the north pier, extending it 500 feet to its full length, and for seven 30 by 50 feet cribs on the new south pier, extending it 350 feet and within six cribs or 300 feet of its total proposed length. The contract also included the construction of the 140 feet of wing-dam to connect the present outer end of the south pier with the inner end of the new south pier extension. All the above piers to be on pile foundations, and the wing pier of two rows of piles 24 feet apart filled with brush and stone. Construction began on June 5, and by the end of the month four of the north pier cribs were under way. The contract provides for the completion of nine cribs and the pile-pier during the present season, and the remaining eight cribs during the season following.

The north pier is in fair condition, needing partial decking and minor repairs. The north revetment needs rebuilding above the water with sheet-piling, to exclude sand from the channel. Sand-fencing also is required. The south pier needs partial refilling, redecking, and minor repairs. The south revetment is very open at the back, admitting sand freely to the channel. This should be stopped with cedar bark and shingle shavings loaded in place and sand-fences erected to arrest the drift on the beach.

With the balance of about $53,000 available June 30, 1889, after deducting work under contract, it is proposed to add the six remaining cribs to the south pier, estimated to cost $28,000; to rebuild 350 feet of north revetment, deck 250 feet of north pier, and make minor repairs, $5,000, including sand-fences; to refill, redeck, and repair the south pier and revetment and construct sand-fences, $6,000, and to pay in part for a dredging plant with two months' work, $8,600. These items, with 10 per cent. for contingencies, will advantageously use the balance and carry the work through the fiscal year ending June 30, 1891, for which, therefore, no appropriation is asked.

The Light-House Establishment maintains a sixth-order light near the end of the south pier, and the Life-Saving Service has a station near the inner end of the north pier.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of the work, 1866	$270,622.00
In 1885	419,185.20
Whole amount appropriated from 1868 to 1889, inclusive	352,435.00
Whole amount expended	241,491.57

Money statement.

July 1, 1888, amount available		$55,377.81
Amount appropriated by act of August 11, 1888		60,000.00
		115,377.81
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$4,146.38	
July 1, 1889, outstanding liabilities	288.00	
July 1, 1889, amount covered by existing contracts	55,769.87	
		60,204.25
July 1, 1889, balance available		55,173.56

Abstract of proposals for pier construction at Ludington Harbor, Michigan, received and opened December 31, 1888.

PIER CONSTRUCTION.

	1. Wolner, Rath & Gaylord.	2. William T. Casgrain.	3. William E. Cook.	4. Hiero B. Herr & Co.	5. Knapp & Gillen.	6. Truman & Cooper.*
Piles:						
Foundation .....per linear foot..	$1.00	$1.00	$0.66	$0.80	$0.80	$0.60
Sheet.....do....	.30	.25	.16	.30	.28	.30
Timber:						
Oak.....per M feet, B. M..	30.00	40.00	35.00	40.00	45.00	40.00
Hemlock .....do....	18 00	21.00	19.75	20.00	18.50	14.00
Pine.....do....	23.00	24.00	25.00	22.00	23.00	20.00
Plank, pine.....do....	20.00	20.00	20.00	20.00	20.00	15.00
Iron:						
Nuts, screw and washer bolts, per pound.....	.05	.06	.05	.04	.05	.04
Drift-bolts and straps...per pound..	.03	.04	.03½	.03½	.04	.03
Wrought spike.....do....	.03½	.05	.05	.04	.05	.04
Stone.....per cord..	9.00	8.00	9.00	6.50	5.75	6.50
Brush .....do....	5.25	4.00	4.00	4.00	4.00	4.00
Dredging foundation...per cubic yard..	.50	.50	.25	.75	.60	.30
Total, seventeen cribs	68, 563. 70	70, 482. 53	68, 677. 21	63, 641. 01	60, 521. 44	52, 417. 97

PILE-PIER.

	1. Wolner, Rath & Gaylord.	2. William T. Casgrain.	3. William E. Cook.	4. Hiero B. Herr & Co.	5. Knapp & Gillen.	6. Truman & Cooper.*
Norway pine piles.....per linear foot..	$0.30	$0.25	$0.18	$0.45	$0.18	$0.12
Pine:						
Timber.....per M feet, B. M..	23.00	24.00	26.00	22.00	23.00	20.00
Plank .....do....	20.00	25.00	20.00	20.00	20.00	15.00
Iron:						
Drift bolts.....per pound..	.03	.04	.04	.03½	.04	.03
Spikes.....do....	.03½	.05	.05	.04	.05	.04
Stone.....per cord..	9.00	8.00	9.00	6.50	6.00	6.50
Brush .....do....	5.25	4.00	4.00	4.00	4.00	3.50
Total, pile-pier.....	4, 857. 19	4, 080. 78	3, 907. 68	4, 541. 11	3, 710. 88	3, 150. 19
Total contract.....	73, 420. 89	74, 563. 31	72, 584. 89	68, 182. 12	64, 232. 32	55, 568. 16

*Contract entered into February 25, 1889.

COMMERCIAL STATISTICS LUDINGTON HARBOR, MICHIGAN.

Vessels entered and cleared.

Years.	Numbers.	Revenue collected.	Tonnage.
Fiscal year—			
1884.....	2, 047	$1, 451. 81	.....
1885.....	1, 468	425. 57	.....
1886	1, 565	520. 00	.....
1887.....	1, 442	.....	259, 800
1888.....	1, 511	.....	270, 316
Calendar year 1888	1, 778	.....	277, 614

K K 6.

IMPROVEMENT OF PENTWATER HARBOR, MICHIGAN.

The project of 1866 was to connect Pentwater Lake with Lake Michigan by a straight cut through the sand-beach to make a channel 150 feet in width with a depth of 12 feet, protecting the entrance by piers and the sides of the cut with revetments.

The north pier projects 650 feet into the lake and the south pier 550 feet, with 1,500 feet of shore revetment on each side of the cut. The width between the piers is 150 feet, and the depths in the protected entrance vary from 9 to 12 feet, the water deepening lakeward from the piers, which terminate in about 14 or 15 feet. The inadequacy of the channel depths is owing to the constant intrusion of sand, part of which is driven in from the lake by the waves, but a much larger portion forced through and over the piers and revetments adjacent to the beach. These constructions must be made sand-tight, and suitable fences constructed to arrest the sand movement before reaching them. The outer 400 feet of the north pier, consisting of crib-work, is in good condition, but needs 300 feet of decking and minor repairs. The inner 250 feet of old pile-pier is decaying, and being comparatively open permits the passage of sand through it. The north shore revetment is in about the same condition. The winds deposit sand against it, and the action of the waves and passing vessels is to suck the sand and water into the channel; in addition to which larger quantities pour over the top during the prevalence of northerly winds. The south pier is in good condition, needing some stone filling, but the south revetment is even in worse condition than the north, the portion adjacent to the beach being decayed and the sand pouring through and over it. The inner or Pentwater end, where the Chicago and West Michigan Railroad terminates, needs rebuilding.

Nothing was done during the past year beyond procuring some material for repairs, with the exception of some dredging which was begun on June 3, 1889, but by collision the dredge was immediately disabled and could not get to work again until June 20. The endeavor will be made to cut a 12-foot channel through with a width of 48 feet to meet present requirements.

Proposals were opened December 22, 1888, for the construction of a crib 50 by 30 by 22½ feet at the end of the south pier. The single bid received amounted to $7,502.21. The work was re-advertised, and on February 25, 1889, seven proposals were received, the lowest being $5,239.62, $2,300 below the first proposal. The crib is to be 50 by 30 by 22½ feet, on pile foundation. Work began in May, and at the close of the year the crib was built to the thirteenth course. Material was procured under contract for the repair of 200 feet of the south revetment.

With the working balance of $2,500, estimated as available July 1, 1889, after allowing for cost of dredging, it is proposed to construct sand fences on both shores, and to make such other repairs to the revetment as the funds will permit.

The existing project calls for the construction of four cribs or 200 feet of extension to the south pier, but the depth in front of the piers is sufficient for the present, and the condition of the channel and the protective works is such as to make it imperative that they should be so repaired as to prevent further accessions of sand. For this purpose both shore revetments, amounting to 3,000 feet, and 350 feet of the north

pier should be sheet-piled and otherwise secured against seepage and wave action. The work will cost about $10,300, to which should be added part cost of dredging plant and services, $8,600, making the estimate for 1891, allowing 10 per cent. for contingencies, $20,800.

The Light-House Establishment maintains a sixth order harbor light, and the Life-Saving Service a station on the north pier.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven.

Original estimated cost of the work, 1866, amended in 1873 and 1884	$262,820.00
Whole amount appropriated from 1866 to 1889, inclusive	225,820.00
Whole amount expended	214,129.88

Money statement.

July 1, 1888, amount available		$5,214.78
Amount appropriated by act of August 11, 1888		8,000.00
		13,214.78
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$1,368.66	
July 1, 1889, outstanding liabilities	156.00	
July 1, 1889, amount covered by existing contracts	9,192.09	
		10,716.75
July 1, 1889, balance available		2,498.03
Amount (estimated) required for completion of existing project		37,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		20,800.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstracts of proposals for furnishing material at Pentwater, Mich., received and opened December 22, 1888.

No.	Name of bidder.	White pine timber, per M feet, B. M.	Drift-bolts, per pound.	Edgings, per cord.	Stone, per cord.	Total.
			Cents.			
1	Stephen Bedford	$21.00				*$796.32
					$9.00	360.00
†2	Geer & Crawford			$3.00		120.00
3	S. D. Kimbark		2.34			117.42
†4	Chicago & Lemont Stone Company, H. L. Holland, receiver				8.24	329.60
†5	Parkhurst & Wilkinson		2.05			102.87

* Contract entered into for timber February 18, 1889.
† Bid accepted. Formal contract waived.

Abstract of proposals for improving harbor at Pentwater, Mich., received and opened December 22, 1888.

Material.	Hiero B. Herr.*	Material.	Hiero B. Herr.*
Piles:		Iron—Continued.	
Foundation, per linear foot	$1.50	Drift-bolts and straps, per pound	$0.06
Sheet, do	.50	Wrought spike, do	.07
Timber:		Stone, per cord	12.00
Oak, per M feet, B. M.	40.00	Brush, do	5.00
Hemlock, do	26.00	Dredging foundation, per cubic yard	2.00
Pine, do	30.00		
Plank, pine, do	24.00	Total for one crib	7,502.21
Iron:			
Nuts, screw and washer bolts, per pound	.07		

* Rejected.

Abstract of proposals for improving harbor at Pentwater, Mich., received and opened February 5, 1889.

Material.	1. E. G. Crosby.	2. Robert Finch.	3. Wm. E. Cook.	4. Wedmer, Rath & Gaylord.*	5. Knapp & Gillen.	6. Truman & Cooper.	7. John Monro, jr.
Piles:							
Foundation, per linear foot	$1.00	$1.00	$1.30	$1.00	$1.50	$1.00	$1.40
Sheet, per linear foot	.50	.40	.40	.33	.40	.30	.30
Timber:							
Oak, per M feet, B. M.	45.00	45.00	50.00	35.00	40.00	40.00	41.00
Hemlock, do	24.00	25.00	25.00	21.00	24.00	19.00	20.00
Pine, do	26.00	29.00	30.00	25.00	27.00	25.00	25.00
Plank, pine, do	20.00	24.00	26.00	20.00	20.00	25.00	23.00
Iron:							
Nuts, screw and washer bolts, per pound	.05	.06	.08	.05½	.06	.05	.05½
Drifts-bolts and straps, per pound	.04½	.05	.06	.04	.05	.04	.05½
Wrought spike, per pound	.06	.05	.08	.05	.05	.04	.06
Stone, per cord	10.00	11.50	12.00	8.50	10.00	9.00	9.50
Brush, do	4.00	5.00	6.00	5.00	4.50	5.00	5.00
Dredging foundation, per cubic yard	1.50	1.50	.80	.66	1.75	1.00	1.25
Total	6,293.02	6,740.63	6,816.96	5,239.62	6,570.33	5,233.80	5,265.51

*Contract entered into March 23, 1889.

Abstract of proposals for dredging 15,000 to 20,000 cubic yards of material at Pentwater Harbor, Michigan, received and opened April 3, 1889.

No.	Name of bidder.	Dredging, per cubic yard.	Total.	Remarks.
1	Robert Finch	*Cents.* 17	$3,400	Contract entered into April 15, 1889.

COMMERCIAL STATISTICS, PENTWATER HARBOR, MICHIGAN.

Vessels entered and cleared.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	461	$400.99	.....
1885	187	69.17	.....
1886	(*)	(*)	.....
1887	(*)	(*)	.....
Calendar year 1888	300	.....	45,000

*Not stated.

K K 7.

IMPROVEMENT OF WHITE RIVER HARBOR, MICHIGAN.

The original outlet from White Lake into Lake Michigan was little more than a narrow drain, navigable only for small vessels.

The project of 1866 was designed to make a straight entrance 200 feet in width between piers and revetments with a channel depth of 12 feet. As constructed, the north pier extends 450 feet into Lake Michigan with 1,050 feet of revetment on the north side of the channel, and the south pier 700 feet with 1,150 feet of revetment.

The width of the entrance is 200 feet and the depth varies from 8 to 13 feet. At the opening of navigation this season but 7 feet could be carried through, the lake being a foot below its normal stage. As in similar cases, constant shoaling occurs between the piers, partly from the action of the waves at the entrance, but in larger amount by wash and seepage of sand through the loose pile-work and filling of the pile-piers and revetments and over them, in the vicinity of the shore-line. The crib-work of the outer 350 feet of the south pier is in fair condition, needing partial decking and filling and minor repairs, but the inner portion, consisting of pile-work, and the entire north pier, which is of similar construction, must be sheet-piled on both sides and refilled from the water up. The same conditions exist with reference to both revetments, which, furthermore, are decaying rapidly from age and exposure. For the protection of the channel and to prevent the constant intrusion of sand it will be needful to sheet-pile their entire length, 2,200 feet, and later to partially rebuild them above the water. During the season of 1888 extensive repairs were made to the upper portion of the north pier for 700 feet of its length, and new filling of edgings put in and ballasted with stone.

Contract was made in February, 1889, for the delivery of material to repair the upper portions of the south pier and north revetment, but so far as practicable the available funds in hand, amounting to about $4,000, will be used towards checking the movement of sand into the channel, leaving enough to redredge in the spring. In April, 1889, contract was made to deepen the channel by dredging. Work began April 23 and continued to June 2, removing 6,343 cubic yards of sand and making two cuts 24 feet wide to a depth of 12 feet, for the temporary relief of the navigation.

For the ensuing fiscal year protective measures against the movement of sand into the channel are necessary, and provision should be made for the following expenditures: Sheet-piling and securing on both sides and refilling 450 feet of north pier and 400 feet of south pier at a cost of $12,120; decking for south pier, $600; sheet-piling the revetment on both sides, $5,500; part payment and use of dredging plant, $8,600. In addition two new cribs should be built on the north pier, costing $11,000. The shoaling outside and above the present north pier sweeps around it into the entrance and the pier needs extension as a defensive measure. This construction will still leave the north pier three cribs, or 150 feet, short of its projected length. With 10 per cent. for contingencies, etc., the estimate for 1890–'91 is $41,600.

The light-house establishment maintains a fourth-order flashing coast light on the shore and a sixth-order harbor light on the south pier. The Life Saving Service has a station on the north pier.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of the work, 1886, amended in 1873 and 1884	$322,755.00
Whole amount appropriated 1865 to 1889	257,500.00
Whole amount expended	250,398.92

Money statement.

July 1, 1888, amount available		$2,575.06
Amount appropriated by act of August 11, 1888		10,000.00
		12,575.06
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$4,291.68	
July 1, 1889, outstanding liabilities	182.00	
July 1, 1889, amount covered by existing contracts	3,826.46	
		8,300.14
July 1, 1889, balance available		4,274.92

Amount (estimated) required for completion of existing project	65,225.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	41,600.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for furnishing material at White River, Mich., received and opened December 22, 1888.

No.	Name of bidder.	White pine timber, per M feet, B. M.	Drift-bolts, per pound.	Edgings, per cord.	Stone, per cord.	Total.
			Cents.			
1	Stephen Bedford*	$31.00				$1,253.45
					$9.00	954.00
2	Hagen & English				8.50	901.00
3	S. D. Kimbark		2.34			263.21
4	Thomas W. Kirby				8.50	901.00
5	Geer & Crawford†			$2.50		225.00
6	A. H. Peteric			3.50		315.00
7	Chicago and Lemont Stone Company, H. L. Holland, receiver‡				8.24	873.44
8	Parkhurst & Wilkinson§		2.05			178.02

* Contract entered into for timber February 25, 1889.
† Bid accepted. Formal contract waived.
‡ Contract entered into for stone February 18, 1889.
§ Bid accepted. Formal contract waived.

Abstract of proposals for dredging 10,000 to 12,000 cubic yards of material at White River Harbor, Mich., received and opened April 3, 1889.

No.	Name of bidder.	Dredging, per cubic yard.	Total.	Remarks.
		Cents.		
1	Robert Finch	17	$2,550	Contract entered into April 15, 1889.

COMMERCIAL STATISTICS, WHITE RIVER HARBOR, MICHIGAN.

Vessels entered and cleared.

Years.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	304	$1,347.23	.....
1885	1,416	476.16	.....
1886	1,623	313.65	.....
1887	1,885	.....	262,440
1888	1,742	.....	184,247
Calendar year 1888	1,408	.....	147,142

Articles entered and cleared, year 1888.*

Articles.	Quantities.	Articles.	Quantities.
Entered:		Cleared:	
Merchandise ..... packages..	11,990	Timber ..... feet, B. M..	61,153,000
Salt ..... barrels..	205	Pickets ..... number..	190,000
Feed ..... tons..	446	Shingles ..... do....	19,770,000
Flour ..... barrels..	256	Lath ..... do....	9,345,000
Oats and corn ..... bushels..	9,400	Slabs ..... cords..	16,544
Lime ..... barrels..	390	Railroad ties ..... number..	9,000
Coal ..... tons..	165	Apples ..... barrels.	2,000

*Compiled from a statement furnished by Mr. George R. Hancock, deputy collector.

K K 8.

IMPROVEMENT OF MUSKEGON HARBOR, MICHIGAN.

The Muskegon River has a drainage area of about 2,400 square miles, discharging a considerable volume into Lake Muskegon and usually maintaining a serviceable outflowing current thence into Lake Michigan.

Between 1849 and 1866 the local interests improved the entrance by building slab piers and revetments, with the expectation of getting rid of a shifting bar of 7 feet that lay off the mouth. These piers were built converging in a length of 700 feet, from 240 feet apart to 175 feet, at the outer end, and in 1865 there was 13 feet of water between them, but the 7-foot bar had transferred itself further into the lake. The Government project of 1866 proposed to give the piers greater extension, so as to cut through the bar to 17 feet of water, but the natural forces kept pace with the construction, and in 1869 it was found that the bar moved out as fast as the piers were extended. Still further extensions were made, the work being embarrassed by the imperfect original slab constructions and by the narrow space between the piers, causing frequent repairs and collisions. In 1881 it was sought to remedy the difficulty by projecting an outer detached north pier, leaving 300 feet interval across to the south pier, and later this was found to involve further extension of the south pier to give it the greater length. By 1885 the outer bar had been so far gotten under that a clear 15 feet could be carried in, although in the year following this was reduced to 14 feet, and in 1887 to 12½ feet, with 13 feet between the piers. At the present time there is a navigable depth between the piers of 14 to 17 feet, and outside them 14 feet, with the deeper contours close at hand. It is evident that the problem of the outer bar is near solution, or has reached it, but it

is also clear that the wash and drift of sand into the channel between the piers have largely reduced the depth it would have, due to the flow of the river and the contraction of the entrance. Furthermore, it has been shown by experience that the 150-foot opening between the end of the old north pier and the outer detached portion should be closed to prevent eddies and accidents. At the present time the north pier has a total projection of 1,050 feet beyond the shore-line, which has greatly advanced since the works were begun. The north revetment has a length of 1,450 feet. The south pier projects 800 feet, and the south revetment is 1,500 feet long. To complete the existing project 8 cribs or 400 feet of the south pier are yet to be added. The condition of the piers in general is good, although the extreme outer crib of the north pier has slipped from or broken down the piles upon which it was supposed to rest, and has thrust its outer end into the lake, projecting downward, apparently intact, with its front a foot under water and the rear end 7 feet above it. The north pier needs some decking and filling. The old slab revetments on both sides need thorough sheet-piling and other repairs for their entire length. About 350 feet of the old south pier of pile-work should be stoutly sheet-piled on both sides.

During the past year no work has been done other than preparatory. Materials were purchased for closing the gap in the north pier, and for repairs to north pier and revetment, and contract was made February, 1889, for the construction of five of the eight remaining cribs on the south pier, 50 by 30 by 24½ feet, on pile foundation.

At the close of the year the repair materials had been delivered, and the cribs were in course of construction, one to the thirteenth course, one to the fourteenth, and two to the second course.

With the estimated working balance of about $13,000 remaining after allowing for cost of repairs, etc., now in progress, it is proposed to restore the equilibrium of the outer crib, and close the gap in the north pier, to double sheet-pile the pile portion of the south pier, and make other minor repairs, holding a balance for operations in the spring.

For the ensuing year provision should be made as follows: Complete the south pier by adding the then remaining three cribs, costing $18,000; sheet-pile 3,000 feet of old slab revetment, $15,000; part cost and service of a dredging plant, $8,600; contingencies, etc., $4,400, making the total requirement for 1891, $46,000.

The Light-House Establishment maintains a fourth-order coast light on the south shore, and a sixth-order harbor light on the south pier.

The Life-Saving Service has a station on the north pier.

The work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866, amended in 1869, 1873, 1881, and 1884	$326,075.00
Whole amount appropriated from 1866 to 1889, inclusive	279,000.00
Whole amount expended	236,545.80

Money statement.

July 1, 1888, amount available		$1,364.18
Amount appropriated by act of August 11, 1888		45,000.00
		46,364.18
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$3,789.98	
July 1, 1889, outstanding liabilities	120.00	
July 1, 1889, amount covered by existing contracts	26,615.99	
		30,525.97
July 1, 1889, balance available		15,838.21

Amount (estimated) required for completion of existing project	$47,075.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	46,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for improving harbor at Muskegon, Mich., received and opened December 22, 1888.

	1. Edward G. Crosby.	2. Hagen & English.	3. Charles Berner.*	4. Hiero B. Herr & Co.
Piles:				
Foundation, per linear foot	$1.00	$1.00	$0.95	$1.00
Sheet, per linear foot	1.00	.28	.30	.40
Timber:				
Oak, per 1,000 feet, B. M	40.00	40.00	40.00	40.00
Hemlock, per 1,000 feet, B. M	17.00	22.00	22.00	20.00
Pine, per 1,000 feet, B. M	24.00	27.00	26.00	24.00
Plank:				
Pine, per 1,000 feet, B. M	18.00	20.00	18.00	20.00
Iron:				
N. S. and W. bolts, per pound	.05	.05	.05	.06
Drift bolts and straps, per pound	.04	.05	.03½	.05
Wrought spike, per pound	.05	.05	.05	.06
Stone, per cord	9.00	7.60	7.50	11.00
Brush, per cord	4.00	4.00	4.00	5.00
Dredging foundation, per cubic yard	.30	.50	.70	.50
Total for one crib	5,405.31	5,147.77	5,028.52	5,738.38
Total for five cribs	27,026.55	25,738.85	25,142.60	28,691.90

*Contract entered into February 26, 1889.

Abstract of proposals for furnishing material at Muskegon, Mich., received and opened December 22, 1888.

No.	Name of bidder.	Pine.		Norway pine piles, per linear foot.	Drift bolts, per pound.	Oak—		Stone, per cord.
		Timber, per 1,000 feet, B. M.	Plank, per 1,000 feet, B. M.			Brush, per cord.	Edgings, per cord.	
				Cents.	*Cents.*			
1	Stephen Bedford	*$18.00	*$18.00	*15	.....	.....	.....	$9.00
2	Thomas W. Kirby	.....	.....	.....	.....	.....	.....	8.50
3	Geer & Crawford	.....	.....	.....	.....	$3.40	†$2.00	.....
4	S. D. Kimbark	.....	.....	.....	2.34	.....	.....	.....
5	E. G. Crosby	22.00	16.00	15	3	4.00	2.00	9.00
6	A. H. Petrie	.....	.....	.....	.....	.....	3.00	.....
7	Chicago and Lemont Stone Company, H. L. Holland, receiver.	.....	.....	.....	.....	.....	.....	‡8.24
8	Parkhurst & Wilkinson	.....	.....	.....	‡2.05	.....	.....	.....

*Contract entered into February 18, 1889. †Contract entered into February 22, 1889.
‡Bids accepted; formal contract waived.

COMMERCIAL STATISTICS, MUSKEGON HARBOR, MICHIGAN.

Vessels entered and cleared.

Years.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	7,160	$4,987.06	.....
1885	6,112	1,621.34	.....
1886	5,543	1,025.17	.....
1887	1,745	.....	232,007
Calendar year 1888	2,655	.....	.....

K K g.

IMPROVEMENT OF GRAND HAVEN HARBOR, MICHIGAN.

This harbor is at the mouth of Grand River, the largest in the State, with a drainage area of some 5,300 square miles. In its original condition the river discharged across the open sand beach between high sand dunes, but its volume was sufficient to maintain a shifting and variable entrance channel of 8 or 9 feet in depth with 15 to 18 feet in the stream inside.

Prior to work by the United States, shore revetments on the south side and a harbor pier with beacon light and fog bell were maintained by the Detroit and Milwaukee Railroad, which had its terminus and depots on the north bank of the river, opposite the present town of Grand Haven.

The original project of 1866, with subsequent modifications, provided for a channel 400 feet in width and a navigable depth of 18 feet, by means of parallel piers projecting into the lake and extensive shore and channel revetments on both banks. In 1880 the project was enlarged to provide for a considerable extension of both piers at a cost additional to the original estimate of about $300,000, with the object of traversing the outer bar and reaching the 20-foot contour in the lake.

As now existing the north pier projects about 1,000 feet and the south pier 1,350 feet beyond the shore line, with 1,850 feet of shore revetment on the north side and 2,350 feet of shore revetment and 1,600 feet of channel revetment on the south side. The north pier still lacks 750 feet of its projected development and the south pier 550 feet. Three cribs, or 150 feet, are to be added to the north pier during the present season. Both piers are generally in good condition, needing only minor repairs. The revetments, particularly on the south side, need considerable repairs, part of which are in progress. The north revetment is in good condition, but should be extended about 1,500 feet to reach the bend of the river. This can be done by a cheap sheet-pile construction costing $4 or $5 per linear foot.

Within the piers and the protected portions of the river the channel depths vary from 3 to 4 fathoms. Outside the piers the depth is less and somewhat variable, ranging between 14 and 16 feet.

During the past fiscal year extensive repairs were made to the south revetments, and these are still in progress, consisting of the cutting down of rotten timber, replacing with new, and restoring the filling of edgings and stone. The above with purchased material and hired labor.

Contract was made in February, 1889, for building three cribs 50 by 30 by 26 feet on pile foundations to extend the north pier. Work was begun in May, and at the close of the fiscal year two cribs had been built to the twentieth course, ready for sinking in place, and the third to the twelfth course, and the foundation for the first crib had been prepared. It is proposed with the balance of about $3,000, which will remain after deducting cost of contract and repair work now in hand, to construct fences costing about 50 cents per linear foot on both sides, and particularly the south shore, to prevent the movement of sand from the beach into the channel, and to hold the remaining sum for such work as shall be found most urgent next spring, and until further appropriation shall have been made.

For the fiscal year 1890–'91, provision should be made for extending the north revetment about 1,500 feet, at an estimated cost of $6,750.

Decking 800 feet of the north pier outside the shore-line, $800; filling and repairing north pier, $400; and paying one-fourth the cost of a dredging plant, with two months' work, $8,600. Ten new cribs should be built, 4 on the south pier and 6 on the north pier, at an estimated cost of $53,000. The number of cribs estimated for is about what can be properly considered as a season's work under one contract, and their construction will still leave 6 cribs, 300 feet of north pier, and 7 cribs, 350 feet of south pier, to be completed. The total of the above items, increased by ten per cent. for contingencies, etc., is $76,500, which should be appropriated for 1891.

The conditions at Grand Haven are altogether more favorable to the construction of a wide and deep entrance suitable for both local commerce and as a harbor of refuge in case of need for the general commerce, than at any other point on the east shore, and the favorable results thus far obtained by the construction of piers and revetments, aided by the large volume of the river, are such as to warrant the expectation that the further expenditures needed to complete the project will be correspondingly justified. The immediate need is for the extension of both piers to about the twenty-foot contour in the lake, beyond which point the water deepens sharply. It is possible that some further extension may be required in the future, but so far as the indications can be studied from the information of record, such extension would in any case be moderate.

Attention is invited to the fact that about three seasons' work is needed to complete the piers, although the remaining 23 cribs could be put in in two seasons by making separate contracts for each pier.

The Light House Establishment maintains a fourth order flashing coast light south of the entrance, and a sixth order light on the south pier, with duplicate fog-signals.

The Life Saving Service has a station on the north pier, inside the shore-line.

This work is situated in the Michigan collection district, Michigan. Grand Haven is a port of entry.

Original estimated cost of the work, 1866, amended in 1880	$652,770.47
Whole amount appropriated from 1852 to 1889, inclusive	549,366.15
Whole amount expended	521,237.83

Money statement.

July 1, 1888, amount available		$10,907.17
Amount appropriated by act of August 11, 1888		25,000.00
		35,907.17
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$7,396.85	
July 1, 1889, outstanding liabilities	382.00	
July 1, 1889, amount covered by existing contracts	19,647.04	
		27,425.89
July 1, 1889, balance available		$8,481.28

Amount (estimated) required for completion of existing project	103,404.32
Amount that can be profitably expended in fiscal year ending June 30, 1891	76,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for furnishing material at Grand Haven, Mich., received and opened December 22, 1888.

No.	Name of bidder.	Pine.		Drift bolts, per pound.	Edgings, per cord.	Stone, per cord.	Totals.
		Timber, per 1,000 feet, B. M.	Plank, per 1,000 feet, B. M.				
				Cents.			
1	Stephen Bedford	$18.00				$7.90	$2,389.30
							*1,445.70
2	Hagen & English					8.50	1,555.50
3	Thomas W. Kirby				$1.20		†768.40
						8.50	1,555.50
4	Cutler & Savage Lumber Company.	16.75					‡2,122.90
			$13.50				‡188.68
5	Geer & Crawford				2.10		1,344.90
6	S. D. Kimbark			2.34			284.45
7	Chicago and Lemont Stone Company.					7.90	1,462.17
8	Parkhurst & Wilkinson			2.05			§369.20

*Contract entered into for stone February 18, 1889.
†Contract entered into for edgings February 21, 1889.
‡Contract entered into March 2, 1889.
§Bid accepted. Formal contract waived.

Abstract of proposals for improving harbor at Grand Haven, Mich., received and opened December 22, 1888.

	1. Hiero B. Herr & Co.	*2. Charles Berner.	3. Hagen & English.	4. Thomas W. Kirby.	5. White & Finch.
Piles:					
Foundation, per linear foot	$1.00	$0.95	$1.05	$0.95	$0.90
Sheet, per linear foot	.40	.30	.28	.23	.25
Timber:					
Oak, per 1,000 feet, B. M.	40.00	40.00	40.00	35.00	40.00
Hemlock, per 1,000 feet, B. M.	22.00	22.00	23.00	25.00	24.00
Pine, per 1,000 feet, B. M	28.00	26.00	27.00	27.00	27.00
Plank:					
Pine, per 1,000 feet, B. M	22.00	18.00	20.00	22.00	20.00
Iron:					
Nuts, screw, and washer bolts, per pound.	.06	.05	.05	.06	.04
Drift bolts and straps, per pound	.05	.03½	.04	.05	.04½
Wrought spike, per pound	.06	.05	.05	.05	.05
Stone, per cord	11.00	7.50	7.75	11.50	9.95
Brush, per cord	4.00	4.00	4.50	4.00	4.00
Dredging foundation, per cubic yard	.50	.60	.50	.50	.60
Total for one crib	5,959.92	4,985.52	5,164.24	6,077.49	5,583.67
Total for three cribs	17,879.76	14,956.56	15,492.72	18,232.47	17,781.01

*Contract entered into February 25, 1889.

COMMERCIAL STATISTICS, GRAND HAVEN HARBOR, MICHIGAN.

Vessels entered and cleared.

Fiscal and calendar years.	Number.	Revenue collected.	Tonnage.
Fiscal year 1884	2,231	$5,221.81	
Fiscal year 1885	1,634	1,965.43	
Fiscal year 1886	1,384	1,548.32	
Fiscal year 1887	1,297		632,150
Fiscal year 1888	1,888		1,036,629
Calendar year 1888	1,508		1,405,080

Articles entered and cleared, 1888.

Articles.	Quantities.	Articles.	Quantities.
Entered:		Cleared:	
Merchandise ..... tons..	79,500	Lumber ..... feet, B. M..	52,000,000
Iron ore ..... do....	35,000	Merchandise ..... tons..	19,500
		Pig iron ..... do....	15,000

K K 10.

IMPROVEMENT OF BLACK LAKE HARBOR, MICHIGAN.

Prior to 1866 the harbor commissioners of Holland, on Black Lake, had made a new outlet into Lake Michigan by cutting through the beach and permitting the accumulated waters of the inner lake to pass out. This was done in a night, but the eroded material was spread out in front of the entrance, forming a bar, with 5½ feet of water. The banks were then revetted with brush piers, and these extended into Lake Michigan by means of cribs on brush bottoms.

The project of 1886 proposed extending the piers about 275 feet to reach the 12 foot curve, and later further extensions were made, but at no time has the condition of the channel been satisfactory; since the absence of any serviceable current in the entrance, through which the flow is as often in one direction as in the other, combined with the vast movement of sand under the influence of wind and waves, and the permeability of the piers and revetments, have combined to reduce the depth as often as the dredge could increase it. As much as 11 feet has been obtained, and as little as 5 feet and 6 feet have followed.

If the harbor is to be kept open, it is evident that means must be taken to prevent the sand from reaching the channel, at least so far as shore protection can effect the purpose, and thereby enable the dredge to make and maintain a navigation.

As now constructed the north pier has a projection beyond the shore of 600 feet and the south pier 780 feet, with 1,270 feet of revetment on the north side of the cut and 900 feet on the south side. In addition, some old wing revetment has been constructed in Black Lake to hold the shore-line. The piers are 200 feet apart at the outer end, terminating in 12 feet to 15 feet of water, with greater depth immediately beyond them in the lake. But between the piers, while a large portion of the channel from Black Lake nearly to the line of the foreshore carries 10 to 12 feet of water, between the shore-line and the ends of the piers, for a distance of 300 feet, the depth is almost uniform at 5½ to 6 feet from side to side. In other words, the sand-fences on both sides of the cut have to a considerable extent protected the inner portion of the channel, but on reaching the shore the beneficial effect of these is lost, and the permeability and low elevation of the piers and revetments permit large accumulations of sand through and over them. During the last season repairs were made to these constructions nearly to the limit of the small amount to the credit of the work. It is needful, as soon as possible, to supplement these repairs by extensive sheet-piling on both piers and revetments, and prevent further sand accumulations. Sand-fences are needed to increase the remoter protection; and to aid the sheet-piling, cedar bark and shingle shavings, which have been found excellent material to check the seepage of sand and water when

properly applied and secured. For this purpose edgings and slabs and such like, however heavily ballasted, cannot be relied upon. The lake sand is fine and will pass almost where water can. Edgings will not pack, and will roll and move when exposed to the sea or the suction of a passing vessel. The water flows through and the sand with it. What is required is a material into which the sand will mat, and, by filling the interstices, arrest its own movement. The bark and shavings referred to are waste products, with but little commercial value, and in most localities in lumber districts can be had for the hauling.

The Government dredge is now under orders for Black Lake as soon as it can complete its work where now engaged. The available balance for dredging is $400, but the citizens of Holland, for the sake of getting temporary relief, propose to subscribe sufficient money to enable the dredge to made at least one cut of 25 feet through the channel.

For the ensuing fiscal year the following provisional estimate is made:

Sand-fences	$1,000
Sheet-piling, etc., 2,170 feet of revetment, at $3.50	7,600
Minor repairs, stone-filling, and sheet-piling, piers when necessary	2,500
Part purchase and three months' use of dredging plant	9,650
Contingencies, etc	2,750
Total estimate, 1891	$23,500

The Light-House Establishment maintains a fifth order harbor light, and the Life Saving Service a station on the south pier.

The work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven.

Original estimated cost of the work, 1866; amended in 1873, 1879, and 1884	$209,071.44
Whole amount appropriated 1852 to 1888, inclusive	264,615.31
Whole amount expended	264,143.84

Money statement.

July 1, 1888, amount available	$2,523.81	
Amount appropriated by act of August 11, 1888	5,000.00	
		7,523.81
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888		7,052.34
July 1, 1889, balance available		471.47
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		23,500.00

COMMERCIAL STATISTICS, BLACK LAKE HARBOR, MICHIGAN.

Vessels entered and cleared.

Years.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	121	$212.54	.....
1885	67	10.57	.....
1886	(*)	(*)	.....
1887	(*)	(*)	.....
Calendar year 1888	60	.....	3,000

*Not stated.

K K 11.

IMPROVEMENT OF SAUGATUCK HARBOR, MICHIGAN.

The town of Saugatuck is situated on the Kalamazoo River, about ½ miles above its mouth. The drainage area of the stream covers some ,750 square miles; its volume is large and current usually strong. The iver now maintains a navigable channel of 8 feet and upwards as far is Saugatuck, and if suitably regulated and protected could be made to naintain 10 or 12 feet. The natural difficulties, however, are more than isually formidable.

Prior to 1867, when it was first examined, a local improvement com- ›any had raised $30,000 by subscription, and invested it in the con- ıtruction of 500 feet of slab-piers and revetments on the north side of he mouth, and 1,575 feet on the south side, with the purpose of remov- ng the bars obstructing the entrance. The depth obtained by these vorks seems to have been about 7 feet. The earliest project, that of 1867, proposed the extension of the piers 200 feet apart to the 12-foot ;urve in the lake, a distance of 416 feet and 1,632 feet, respectively, with he object of securing a channel of 10 or 12 feet depth. As these piers, ogether with the necessary dredging and other adjuncts, would cost ›ver $200,000, and as in any case extensive revetments would be needed nside the mouth for considerable distances, it was decided to undertake hese works first and maintain the existing piers by suitable repairs ınd modifications.

As now existing both piers project 200 feet beyond the shore-line, which ıas advanced since 1867 by some 250 feet, the angle of the piers with the ihore-line being such that the end of the north pier is about opposite he base of the south pier. The north pier is apparently open pile-work rom the subsidence and loss of the filling, and the waves and sand wash hrough it freely. The south pier is of better construction and less per- neable. No additions have been made to these constructions since 1876. The old north revetment is in a ruinous condition, and what remains of t near the lower bend of the river should probably be taken out. Less ıttention was given to this side of the stream, as the south or concave ıide is that against which the stream presses and needed regulation. The south revetment is some 3,650 feet in length, reaching to and around he lower bend of the river. The latest portions of it were built in 1874, and the structure above the water, including the piles which sup- port it, is nearly all rotten, except where new material to a moderate ımount has been introduced to save it from destruction. The filling ıas sunk to below the water-line, and the river passes through it near he bend, and out again into the channel further down.

If this navigation is to be maintained radical measures are needful, ınd unless this is the intention it would seem better to abandon it alto- gether than to spend money on repairs in the useless attempt to prolong he life of dilapidated structures that in the course of a few years at nost must be largely rebuilt or perish altogether. The greatest difficulty o contend with, one which has existed from the beginning, and which ıas neutralized both the power of the stream and the aid given it by he shore revetments and constructions, is the broad expanse of naked ıand that lies on the north side of the river and for a distance of three- ourths of a mile adjoins it in the reach between the lower bend and the ıbandoned village of Singapore in the bend above. Over this desert he sand is in constant movement with the wind, and every year enor-

mous quantities of it pour into the river and are transported by the current into the lower reach and beyond the piers. If anything is to be done towards deepening the navigation it is imperative to revet the north bank to above the sand hills, and fence those in the vicinity of the river, so that the influx of sand may be stopped. With this hostile factor eliminated the remaining revetments can be sheet-piled, and the piers extended 800 feet to the 15-foot curve, which, with dredging from time to time, will maintain a 12-foot navigation as was originally projected.

The cost of this work is roughly computed at $300,000.

During the past year nothing was done except to contract for the delivery of some repair material. As these repairs pertain to the upper portions only of the south revetment, and as the real requirement, if any, is to make those revetments tight below, the question as to the best disposition of the repair materials will be considered, and until it can be decided what measures should be taken with regard to the future navigation no appropriation is asked for the ensuing year.

The Light-House Establishment maintains a fifth-order harbor light on the south pier.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of the work, 1867, modified in 1869, 1870, 1875, and 1882	$175,699.46
Whole amount appropriated from 1868 to 1889, inclusive	140,439.00
Whole amount expended	134,998.88

Money statement.

July 1, 1888, amount available		$963.37
Amount appropriated by act of August 11, 1888		5,000.00
		5,963.37
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$543.25	
July 1, 1889, amount covered by existing contracts	1,871.70	
		2,414.95
July 1, 1889, balance available		3,568.42

Abstract of proposals for furnishing material at Saugatuck, Mich., received and opened December 22, 1888.

No.	Name of bidder.	White pine timber per M feet, B.M.	Drift-bolts per pound.	Totals.
			Cents.	
1	Geer & Crawford	$18.85		*$1,750.79
2	S. D. Kimbark		.03	176.94
3	Stephen Bedford		.02.34	138.61
4	Parkhurst & Wilkinson	21.00		1,950.48
			.02.65	†126.91

* Contract entered into for timber February 22, 1889.
† Bid accepted; formal contract waived.

COMMERCIAL STATISTICS, SAUGATUCK HARBOR, MICHIGAN.

Vessels entered and cleared.

Fiscal and calendar years.	Number.	Revenue collected.	Tonnage.
Fiscal year 1884	300	$422.84	.....
Fiscal year 1885	265	118.86	.....
Fiscal year 1886	(*)	(*)	.....
Fiscal year 1887	(*)	(*)	.....
Calendar year 1888	662	.....	132,400

* Not stated.

**Articles entered and cleared,* 1888.

Articles.	Quantities.	Articles.	Quantities.
Entered:		Cleared—Continued:	
Merchandise ..... tons..	3,250	Fish ..... tons..	60
Grain ..... bushels..	10,000	Apples ..... bushels..	5,000
Cleared:		Fruit ..... baskets..	1,000,000
Lumber ..... feet, B. M..	2,000,000		

* Compiled from a statement furnished by Mr. R. C. Britain, Saugatuck, Mich.

K K 12.

IMPROVEMENT OF SOUTH HAVEN HARBOR, MICHIGAN.

When examined in 1866 the mouth of Black River, which is the harbor of South Haven, had been protected at the cost of the citizens by piers and piling, and had an entrance width of 85 feet and a depth of 7 feet, with an outer bar of 9 or 10 feet.

The project of 1866, as later modified in 1869 and 1872, designed an entrance of 180 feet width and 12 feet navigable depth.

As constructed, the north pier projects 800 feet into the lake and the south pier 700 feet, with 800 feet of north revetment and 950 feet of south revetment on the banks of the river. The outside bar has 12½ feet of water, there are 13 and 14 feet between the ends of the piers, and, with the exception of an interval of 300 feet, 10 feet of water can be carried through the channel and the river as far as the bridge, about 4,000 feet up-stream. The interruption to the 10-foot channel, above noted, as usual in such cases, lies outward from the line of the beach, and the depth decreases from 10 to 8 feet. The position of the obstruction indicates its origin. It is formed in part of material forced into the entrance by the action of westerly gales, but in larger proportion of sand-drift from the beach over and through the revetments. The drainage area of Black River does not exceed 250 square miles; its volume is comparatively small and its power moderate. It is able apparently to maintain a narrow 10 and 12 foot channel where the shores are protected from erosion, but can not maintain that depth in conflict with the large accessions of sand in the vicinity of the beach. The remedy is also obvious—the movement on the beach towards the channel must be checked at some distance from the revetments, and these must be made tight enough to prevent the passage of sand through them. As neither of these measures can be made absolutely effective, and as more or less material is certain to reach the channel from the banks and

from the lake, reliance in the end must be had upon the dredge to hold the channel at such depth as the navigation of the port shall require.

The general condition of the works is fairly good. The south pier is in good condition, needing some decking. The north pier needs filling and decking, and the outer crib is so badly damaged from the action of ice, and possibly collisions, as to require rebuilding from a depth of 6 or 8 feet below the water. The south revetment on the inhabited bank is in serviceable condition, but is built of slabs and piling, and should be sheet-piled to make it tight. The north revetment should be similarly treated, and the inner 400 feet of it, of the "plank-beam" type, rebuilt. For 100 feet of the shore-end both north and south piers should be sheet-piled on both sides to prevent the washing of sand through them by the waves.

Contract was made in March, 1889, in pursuance of previous advertisements for the construction of a crib 50 by 30 by 24½ feet on pile foundation at the end of the north pier. But subsequent investigation showed that the condition of the outer crib and of the channel between the piers was such that it was needful to give them prior attention. The dredge was sent to South Haven in May, and between the 3d and 16th took out 6,000 cubic yards, making a cut 25 feet wide to a depth of 13 feet, and opening a clear 12-foot channel.

During the present year it is proposed to effect a modification of the crib contract, so as to provide for the purchase of the material, but omitting the construction, which will have to be postponed.

With the balance of $3,700, available for repairs, after discharging liabilities and reserving the dredging allotment, it is proposed to make the repairs to the outer crib and pier, construct sand fencing, and if practicable a portion of the sheet-piling on the north shore.

For the ensuing year there will be needed: To sheet-pile 200 feet of north pier and 100 feet of south pier, $2,400; to sheet-pile 350 feet of north revetment and rebuild 400 feet, $4,950; to sheet-pile 900 feet of south pier, $3,600; to part purchase and use of dredging plant, $8,600. The total of these items is $19,550, which with 10 per cent. for contingencies constitutes the estimate for the fiscal year 1891, $21,500.

The amount required for these purposes is in excess of the average appropriations that have been made for the work, and as they are required to maintain the navigable depth which it is the purpose of the appropriation to secure, no estimate is made at this time for the extension of piers.

The light-house establishment maintains a fifth order light on the south pier, and the life-saving service a station on the north pier.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of the work, 1866, amended in 1869 and 1872	$257,426.80
Whole amount appropriated from 1866 to 1889 inclusive	192,000.00
Whole amount expended	183,147.27

Money statement.

July 1, 1888, amount available		$19.95
Amount appropriated by act of August 11, 1888		10,000.00
		10,019.95
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$1,167.22	
July 1, 1889, amount covered by existing contracts	5,837.08	
		7,004.30
July 1, 1889, balance available		3,015.65

Amount (estimated) required for completion of existing project	$21,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	21,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for improving harbor at South Haven, Mich., received and opened December 22, 1888.

Material.	Hiero B. Herr & Co.*	Material.	Hiero B. Herr & Co.*
Piles:		Iron—Continued.	
Foundation ....per linear foot..	$2.00	Drift-bolts and straps, per pound	$0.06
Sheet.....do....	.50	Wrought spikes....per pound..	.07
Timber:		Stone.....per cord..	12.00
Oak .....per M feet, B. M..	50.00	Brush .....do....	5.00
Hemlock .....do....	28.00	Dredging foundation ..per cu. yd..	1.50
Pine .....do....	34.00		
Plank, pine.....do....	30.00	Total of bid.....	7,707.29
Iron:			
Nuts, screw, and washer bolts, per pound.....	.07		

*Rejected.

Abstract of proposals for improving harbor at South Haven, Mich., received and opened February 25, 1889.

Material.	1. Ed. G. Crosby.	2. Hiero B. Herr & Co.	3. Truman & Cooper.	4. Weimer, Rath & Gaylord.*	5. Knapp & Gillen.	6. Geer & Crawford.	7. John Munro, jr.	8. William E. Cook.	9. Robert Finch.
Piles:									
Foundation . per lin. ft..	$1.00	$1.50	$1.50	$1.00	$1.50	$1.20	$1.50	$1.50	$1.00
Sheet .....do....	.50	.40	.50	.40	.40	.40	.40	.60	.40
Timber:									
Oak ....per M ft., B. M..	45.00	50.00	50.00	40.00	40.00	40.00	40.00	50.00	45.00
Hemlock.....do....	24.00	25.00	26.00	24.00	25.00	24.00	22.00	28.00	26.00
Pine .....do....	26.00	30.00	30.00	28.00	29.00	31.00	25.00	30.00	30.00
Plank, pine .....do....	20.00	30.00	30.00	22.00	25.00	28.00	23.00	30.00	25.00
Iron:									
Nuts, screw, and washer bolts .....per lb..	.05	.06	.06	.05½	.06	.06	.06	.08	.06
Drift-bolts and straps, per lb	.04½	.05	.05	.04	.05	.05	.05	.06	.05
Wrought spikes..per lb..	.06	.06	.05	.05	.07	.06	.06	.08	.05
Stone .....per cord..	10.00	11.00	11.00	9.50	10.00	10.00	9.50	12.00	11.50
Brush.....do....	4.00	5.00	5.00	5.00	5.00	3.00	5.00	6.00	5.00
Dredging foundation, per cu. yd	1.50	2.00	2.00	.80	1.75	1.25	1.25	1.00	1.50
Total of bids	6,293.02	7,068.27	7,214.96	5,837.08	6,717.23	6,359.44	6,093.98	7,347.15	6,835.84

*Contract entered into March 23, 1889.

COMMERCIAL STATISTICS, SOUTH HAVEN HARBOR, MICHIGAN.

Vessels entered and cleared.

Fiscal year.	Number.	Revenue collected.	Tonnage.
1884	466	$555.72	.....
1885	361	204.50	.....
1886	283	113.55	.....
1887	264	.....	52,800
1888	420	.....	29,134

K K 13.

IMPROVEMENT OF ST. JOSEPH HARBOR, MICHIGAN.

This work has been under improvement by the United States since 1836.

The project of 1866, modified in 1874, had in view an entrance depth of 16 feet. This, and more, has been fully secured between the piers, but the depth in the open lake, 200 to 250 yards in advance of the piers, limits the draught to 15 feet, which can not be increased without very considerable expenditure for pier extensions and dredging. Inside the piers the natural regimen of the basin, with judicious treatment, will suffice to maintain channel depths of 12 to 13 feet, and to increase this to 15 feet the services of a dredge are necessary.

The Benton Harbor Canal is practically without current, and to maintain the channel more or less frequent dredging will be required, although it may be found practicable and advisable hereafter to modify this feature somewhat, and improve the sanitary conditions of the canal by admitting into its upper level a limited and controllable portion of the volume of the Paw Paw River. This is a matter for consideration after careful ascertainment of data. So far, therefore, as the main works are concerned, the results already attained, or readily attainable, may be regarded as substantially meeting the requirements of the project, although much remains to be done for the development of the naturally good commercial facilities of the harbor in obtaining and holding adequate channel depths and widths by the use of the dredge, and in providing for the due repair, security, and efficiency of the permanent constructions upon which the future maintenance of the navigation must depend.

As in all similar cases, these have suffered from the delays and postponements due to insufficient and deferred appropriations for their construction, so that before a pier whose full extension is needful to secure the desired depth can be completed, the earlier part of it has already decayed and must be largely rebuilt. In some cases this operation is gone through several times before the terminal work can be done; and the ultimate cost of construction is thereby seriously enhanced.

The north pier at St. Joseph has a total length of 1,526 feet, of which 740 feet project beyond the shore-line. The outer 830 feet is crib-work 24 feet to 30 feet wide, and the remainder is pile revetment, 14 feet to 16 feet wide. Considerable repairs are needed to the middle and inner portions of the pier.

The south pier is 819 feet long, of which 690 feet project beyond the shore; 213 feet are of old crib-work 24 feet wide, and 606 feet of pile revetment, 14 feet wide. During the past year 64 feet at the outer end of the south pier was repaired to a depth of four courses and filled with stone, and the entire pier (819 feet) was decked.

Contract was made in April, 1889, for the construction of a wing-dam 176 feet long and 10 feet wide, of piles and timber and fascine and stone filling, to connect the damaged inner end of the north pier with the shore, and work was begun May 15, 1889. At the close of the year the pile and timber work was completed and the filling well advanced. The Life-Saving station stands near the inner end of the pier, and the water here inclosed by the wing-wall forms a convenient harbor, for which reason an opening was left in the wing-wall to permit boats to enter. The dredging work in progress at the beginning of the year was continued until July 10, when the funds gave out. With the appropriation of August 11, 1888, work was renewed in October and prolonged until December 8, when the plant was laid up for the winter.

Dredging began again in April, and with the exception of two weeks in May, when the dredge was sent to South Haven to open the channel, was continued until June 15. The work, as completed, was the removal of 24,840 cubic yards, making a cut 25 feet to 28 feet wide and 13 feet deep in the Benton Harbor Canal, and below the canal widening the channel to 75 feet with the same depth as far as deep water between the piers.

With the $4,000 of balance remaining to carry on the work until further appropriation shall have been made, it is proposed to expend about $1,500 in continuing the dredging between Benton Harbor and the entrance, and $2,500 in making needed repairs to the north pier..

For the year ending June 30, 1891, provision should be made for widening, revetting, and deepening the Benton Harbor Canal, estimated to cost $12,750; repairing piers, $2,250; widening and deepening channel in harbor, $10,000, and part purchasing dredging plant, $6,500. These items, with allowance for contingencies, etc., make the estimate for 1890–'91 $35,000.

From the early history of lake navigation, St. Joseph Harbor, from its natural advantages as a port and harbor of refuge and convenient access, has been regarded as one of the important harbors on the east shore of the lake.

By the aid of the outflow from the two rivers discharging into the basin the entrance depth can be reliably maintained, without undue expenditures, at 15 feet, and with the inner navigation deepened to correspond, and enlarged to quite practicable areas, it will be one of the most valuable for commercial purposes on the lake.

As the littoral drift and the resultant wind and wave action tend to an accumulation of sand against the north pier, it may hereafter be needful to extend this, but with the present development and depth no extension is necessary, and needed attention can be directed to enlarging the harbor facilities proper.

The existence of the railroad bridge across the mouth of the harbor, inside the piers, has ever since its construction in 1870, impaired the free use of the harbor, particularly as a harbor of refuge. The draw has recently been widened from 60 to 100 feet, but at the close of the fiscal year the draw-channels were still obstructed with piles and débris.

The Light-House Establishment maintains a fifth-order light at the end of the north pier, and has recently re-established the fourth-order revolving coast light on the bluff in St. Joseph. The Life-Saving Service has a station at the inner end of the north pier.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, as now being carried on	$128,288.47
Whole amount appropriated from 1836 to 1889, inclusive	354,613.00
Transferred to Grand Haven (Report 1870, page 44)	500.00
Whole amount expended	347,906.34

Money statement.

July 1, 1888, amount available		$505.10
Amount appropriated by act of August 11, 1888		12,000.00
		12,505.10
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$5,517.44	
July 1, 1889, outstanding liabilities	781.00	
July 1, 1889, amount covered by existing contracts	2,895.22	
		9,193.66
July 1, 1889, balance available		3,311.44

Amount that can be profitably expended in fiscal year ending June 30, 1891, Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867. 35,000.00

Abstract of proposals for improving harbor at St. Joseph, Mich., received and opened December 22, 1888.

	1. Hiero B. Herr & Co.	2. John Munro, jr.	3. John M. Allmendinger.*	4. Geer & Crawford.	5. White & Finch.
Piles, Norway pine .....per linear foot..	$0.30	$0.31	$0.23	$0.21	$0.31
Pine:					
Timber.....per M feet, B. M..	32.00	26.00	24.00	20.00	28.00
Plank.....do....	30.00	25.00	24.00	15.00	25.00
Iron:					
Drift-bolts.....per pound..	.06	.05½	.03	.03	.03½
Spikes.....do....	.07	.06	.03½	.05	.05
Brush.....per cord..	5.00	4.00	2.24	3.20	4.00
Edgings.....do ...	5.00	4.00	4.00	3.50	4.00
Stone.....do....	13.00	11.00	10.00	9.00	8.00
Total amount of bid.....	4,979.13	4,249.98	2,895.22	3,135.20	4,101.71

*Contract entered into April 3, 1889.

COMMERCIAL STATISTICS, ST. JOSEPH HARBOR, MICHIGAN.

Vessels entered and cleared.

Years.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	560	$1,696.14	.....
1885	467	361.57	.....
1886	789	248.53	.....
1887	589	.....	144,000
1888	679	.....	208,797
Calendar year 1888	966	.....	259,925

The following statement was furnished by the Graham & Morton Transportation Company, Benton Harbor, Mich.:

Merchandise carried (tons, 3,000)	value..	$400,000
Lumber (feet, B. M., 20,000,000)	do....	200,000
Passengers carried	number..	16,078

K K 14.

IMPROVEMENT OF ST. JOSEPH RIVER, MICHIGAN.

The river and harbor act of August 11, 1888, appropriated $2,500 for "improving St. Joseph River from its mouth to Berrien Springs." The combined waters of the St. Joseph and Paw Paw rivers discharge into Lake Michigan through an interior natural basin, which is known as St. Joseph Harbor, and has a separate appropriation for its improvement. It appears, therefore, that the act regarded the mouth of the St. Joseph River as the point at which the basin is reached, and intended the $2,500 appropriation to facilitate the navigation thence to Berrien Springs to such an extent as should be practicable with the sum allotted. The Annual Report of the Chief of Engineers for 1880, Part III, pages 2049–2055, contains a report of an examination of the stream and a provisional estimate of $11,300 for its improvements to Berrien Springs, a distance of 25 miles, by means of cuts through the shoals and wing-dams at certain points to secure a depth of from 2 to 3 feet at low stages.

In October, 1888, Lieutenant Kuhn made a further examination, and reported that at extreme low water an available depth of 2 feet was found, and that a depth of 3 feet could be secured by the removal of logs and snags and the construction of a few wing-dams of brush and stone.

The only vessel trading on the river is the *May Graham*, a side-wheel steamer of about 95 tons, drawing 24 inches light and 30 inches loaded. The difficult points are six or seven in number, falling into two classes, one in which sand or gravel bars lie across the stream and the other where islands divide the channel, the convex side being usually obstructed with sand and the concave side with heavier material. In the former case the bars can be deepened by the removal of sunken logs, permitting the current to erode a channel; in the latter case it is desirable to amend the obstructions with as little interference as may be with the natural regimen, and to provide for a slight elevation of the water-level to quicken the current through the sand-shoal on the convex side by building a low dam across the concave channel at some convenient point below the head of the island, leaving space in which the gravel can rest and freshets pass freely, the object being merely to create current enough at low stages to maintain a channel through the sand-beach.

With the small sum available more elaborate provision would be out of the question, even supposing the character and value of the navigation to warrant larger expenditures.

A project to the above effect was submitted March 20, 1889, and approved March 27, 1889, to include the construction of two scows and derrick for the use of the snagging and construction party.

Contracts were made for these to be completed by July 1, soon after which date work on the river will begin.

If the maintenance and continuation of the work be thought advisable, it would be well to make an appropriation of $1,000 to strengthen the works proposed at this time and supplement them with others where found needful.

Money statement.

Amount appropriated by act of August 11, 1888		$2,500.00
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$16.48	
July 1, 1889, amount covered by existing contracts	250.00	
		266.48
July 1, 1889, balance available		2,233.52
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1837.		1,000.00

K K 15.

IMPROVEMENT OF MICHIGAN CITY HARBOR, INDIANA.

OUTER HARBOR.

The original harbor at Michigan City was made, as in similar cases, by dredging the bed and revetting the banks of Trail Creek, and building piers projecting into the lake on both sides of the entrance.

As the work progressed, the remarkable expansion of the lake commerce, particularly of Chicago and the other upper lake ports, combined

with the peculiarly exposed position of Michigan City, which, lying at the head of the lake at the extremity of its larger axis, receives the shock of the north and northwest gales, the heaviest to which the lake commerce is subject, with no other harbor nearer than 35 miles, drew attention to the desirability of making a harbor of refuge at Michigan City for the general benefit.

The weight and duration of the northwest gales raised a powerful and dangerous sea at the narrow entrance into Trail Creek, which opened directly towards them, and across which ran strong currents to the westward, so that there could be little hope of security for a vessel driven by stress of weather to the southward of Chicago or St. Joseph and forced to seek shelter or go to the beach. Furthermore, the agitation at the entrance was often transmitted inward between the piers so as to disturb vessels loading at the wharves.

In 1870, therefore, the project for an "outer harbor" for the combined local and general benefit was prepared. This project called for the construction of an inclosed "outer basin" adjacent to the shore eastward of the entrance by the extension of the then existing west pier 550 feet northward, with a total projection of 1,450 feet, and the construction of a new east pier, which, starting from a point 1,400 feet farther east, should extend into the lake for a distance of 1,100 feet, connecting with a "breakwater," which ran thence westward towards the outer end of the west pier, and leaving an opening 200 feet in width at the northwest angle of the basin so formed, which inclosed about 35 acres. Construction was begun in 1872 and continued to 1884, when the work was completed by the closing of a gap of 150 feet at the northeast angle, formed by the east pier and the breakwater. The inclosed area still contained the sand which had not been removed, and had received large accessions through the two openings at the northeast and northwest angles, so that less than one-third of the area had a depth of 12 feet. Meanwhile great difficulty was experienced with the retention of the narrow entrance facing northward down the lake, receiving the seas from that direction, and crossed by the prevalent and at times powerful current sweeping past the mouth from east to west. As a protection against this current, an additional work was projected in 1880 to extend 500 feet from the west end of the breakwater northward into the lake, and guard the entrance on the east side, leaving it, however, still open to the northward. Between 1882 and 1885 350 feet of this "breakwater pier" were constructed, leaving 150 feet to complete it.

In 1882, finding, as was stated by the Board of that date, that "the defect in the present plan appears to be that it does not afford a sufficiently safe entrance for vessels," which was the purpose of the construction, and, as stated by the engineer in charge, "the entrance is so narrow and exposed to currents that many wrecks and accidents have occurred," "while I have been in charge several vessels have missed the entrance and been driven on the beach," a new work was projected called the "Outer Breakwater." This was to be 2,000 feet in length, with two arms of equal length, making an angle of 135 degrees with each other. The east end of the work was to begin at a point 400 feet west of the outer end of the "Breakwater Pier," leaving that space as an entrance opening, and extending westward for 1,000 feet to the angle. The west arm thence extends 1,000 feet, inclining toward the shore and leaving an interval of 450 feet between its westernmost extremity and the 18-foot curve of the shore.

If this work is constructed as now proposed it will afford an area of

protection against northerly gales of about 30 acres in extent, but the means of access are hardly such as a work designed for the benefit of the general commerce will require. The west entrance is too near the beach to give a vessel in distress that sense of security that would encourage her to seek it, while the E entrance, through the 400-foot gap, swept by the cross-current and confronted by the end of the west pier projecting towards its middle point, would be a hazardous opening to run for in heavy weather or at night.

In this connection, also, the following considerations are of importance: The main difficulty with the original entrance between the piers at the mouth of Trail Creek was its exposure to northerly winds and seas. The "Outer Basin" was built both as a local and general harbor of refuge, but can not at the present time be used, even were the sand dredged out, for the reason that the entrance is too narrow and dangerous for the purpose, and because the northwest winds and seas drive into the basin without let or hindrance. Under the present plan for the "Outer Breakwater" this open northerly entrance is still retained, and the increase in width, while serving one useful purpose of giving a vessel a better chance to make it, introduces the counterbalancing disadvantage of admitting the sea with still greater freedom into the harbor within. In other words, so long as this open entrance northward is retained so long will the Outer Basin, upon which the United States have expended a large sum of money, be useless, since, even if dredged out and the shore built up with wharves, no vessel could anchor or lie there except in smooth weather.

During the past fiscal year the outer end of the west pier was decked, and is now in good condition throughout. In March, 1889, contract was made for the completion of the "Breakwater Pier" by the addition of three 50 by 30 feet cribs on stone foundation, and for commencing the construction of the "Outer Breakwater" by the placing of 10 cribs 50 by 30 feet at its eastern end. Work began in May, and by June 30 the contractors had sunk the three cribs on the "Breakwater Pier," filled and decked them.

In addition to the above, three cribs for the Breakwater had been built up to the sixteenth, eleventh, and fourth courses respectively.

During the northeast gale of May 30 the contractors lost two cribs, which were ready for placing, by pounding against the west pier and the bottom while lying in the entrance to the inner harbor.

The present breakwater will need extensive repairs within a few years. The west end in particular, which was built in 1875, is in a somewhat hazardous condition, but may go for another year. The east pier of the basin is in very defective condition. It was originally a pile-pier, and is so open below that water flows freely through it and pours sand into the basin. It should be completely sheet-piled on the outside, refilled with stone, and redecked for its entire length of 1,100 feet.

Of the balance remaining to the credit of the appropriation on June 30, 1889, of about $35,500, it is proposed to reserve $19,500 to complete the thirteen cribs now constructing under contract, and to use so much of the remaining $16,000 as shall be necessary to make the indicated repairs to the east pier and hold a working balance for the spring of 1890.

For 1891 provision should be made for the construction of ten new cribs for the "Outer Breakwater," adding 500 feet to its length at an estimated cost complete of $75,000; for the purchase of a tug for the harbor at a cost of $10,000, and to do about $1,000 of dredging near

the outer entrance. The total of these amounts is $86,000, and with allowance for contingencies the estimate for 1891 is $95,000.

The Light-House Establishment maintains a coast light on the east side of the entrance, and the Life-Saving Service a station on the old east pier near the shore-line.

This work is located in the collection district of Chicago. The nearest light-house is at Michigan City. The nearest port of entry is Chicago, Ill.

Original estimated cost of project, 1870	$324,421.40
Increase by cost of repairs and maintenance to 1889	87,567.10
Project for Outer Breakwater, including dredging of Outer Basin, 1882	587,000.00
Total estimates	998,988.50
Whole amount appropriated 1870 to 1889, inclusive	669,375.00
Whole amount expended	576,525.58

Money statement.

July 1, 1888, amount available		$20,903.83
Amount appropriated by act of August 11, 1888		90,000.00
		110,903.83
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$17,802.41	
July 1, 1889, outstanding liabilities	252.00	
July 1, 1889, amount covered by existing contracts	57,352.41	
		75,406.82
July 1, 1889, balance available		35,497.01
Amount (estimated) required for completion of existing project		329,613.50
Amount that can be profitably expended in fiscal year ending June 30, 1891		95,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for improving Outer Harbor at Michigan City, Ind., received and opened December 22, 1888.

	1. William T. Casgrain.	2. Jos. L. Gearing.	3. Hiero B. Herr & Co.*
Timber:			
Oak, per M feet, B. M	$40.00	$38.00	$40.00
Hemlock, per M feet, B. M.	23.00	28.00	23.00
Pine, per M feet, B. M	26.00	32.00	28.00
Plank: Pine per M feet, B. M	25.00	28.00	22.00
Iron:			
Screw and washer bolts, per pound	.06	.07	.05
Drift-bolts, per pound	.04	.05	.04
Spikes, per pound	.05	.05	.05
Stone, per cord	10.00	11.00	9.00
Total for one crib	5,643.92	6,504.81	5,328.00
Total for thirteen cribs	73,370.96	84,562.53	69,239.17

*Contract entered into March 16, 1889.

INNER HARBOR.

This work, begun in 1836, has since been continued, partly at the cost of the United States and partly that of Michigan City, the purpose, as at other similar places, being to convert a narrow and crooked creek into a harbor where vessels could enter to load or discharge, by dredg-

ing out the bed, revetting the banks, and building piers projecting into the lake on each side of the entrance.

Up to 1866 about $231,000 had been expended by the United States for the purpose, and in that year Congress appropriated a further sum of $75,000, to be available if it could be shown that the Michigan City Harbor Company had expended $100,000 for the improvement. The company being able to make a satisfactory exhibit, the engineer in charge, upon examination of the locality, found the piers extending, respectively, 1,135 feet and 994 feet into the lake and 100 feet apart, but from decay of the old structures and the intrusion of sand from the lake and blown over the sides the depth was quite insufficient. An extension of the pier for about 300 feet, to cross a bar obstructing the entrance, was recommended, with dredging to give 12 feet of water. The project was later extended both in the length of the piers and the additions to length of creek to be dredged and revetted. At the present time the west pier has a total length beyond the shore of 1,450 feet, of which 550 feet are due to the project for the "Outer Harbor." The pier is in good condition. The northeast pier projects 700 feet, but since the construction of the "Outer Basin" it has become practically useless and has fallen to decay.

The interior extension of the dredging and revetments has reached a distance of —— feet from the mouth, at the shore-line.

The works are in fair condition, and the dredge, originally procured and operated by Michigan City and transferred to the United States, maintains a navigable channel of 15 feet to 13 feet, with less depth to the upper reaches.

During the past year 64,085 cubic yards were taken from the channel and dumped into the lake, in 40 feet of water, westward from the entrance.

For the fiscal year 1891 provision should be made for continuing the channel dredging $5,000, for a new dump-scow $2,500, and for contingencies, etc., $1,500, making a total of $9,000.

Amount appropriated and expended from 1836 to 1866, inclusive	$231,203.92
Original estimated cost of existing project, 1870	100,000.00
Whole amount appropriated, 1870 to 1889, inclusive	101,875.00
Whole amount expended	99,202.16

Money statement.

July 1, 1888, amount available		$2,978.57
Amount appropriated by act of August 11, 1888		5,000.00
		7,978.57
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$4,890.73	
July 1, 1889, outstanding liabilities	415.00	
July 1, 1889, amount covered by existing contracts		5,305.73
July 1, 1889, balance available		2,672.84
Amount that can be profitably expended in fiscal year ending June 30, 1891 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		9,000.00

COMMERCIAL STATISTICS, MICHIGAN CITY HARBOR, INDIANA.

Vessels entered and cleared.

Years.	Number.	Revenue Collected.	Tonnage.
Fiscal year—			
1885	1,334	$116.35	
1886	966	90.10	
1887	1,090		213,0[illegible]
1888	1,167		212,67[illegible]
Calendar year, 1888	1,153		206,61[illegible]

Articles entered and cleared January 1, 1888, *to December* 31, 1888.

Articles.	Quantities.	Articles.	Quantities.
Entered:		Cleared:	
Lumber.....feet, B. M..	101,226,800	Merchandise.....tons..	3,000
Lath.....number..	10,352,000	Hay.....do....	50
Shingles.....do ..	73,405,000	Oats.....bushel..	6,000
Cedar posts.....do ..	50,000,000	Coal (soft).....tons..	2,000
Wood.....cords..	350	Cattle.....number..	50
Pig-iron.....tons..	2,358		
Salt.....barrels..	116,000		
Coal.....tons..	800		

Estimated value of articles received and shipped: $1,755,348.00.

K K 16.

PRELIMINARY EXAMINATION OF SAUGATUCK HARBOR, MICHIGAN, TO OBTAIN CHANNEL OF NAVIGABLE WIDTH, WITH A MINIMUM DEPTH OF FIFTEEN FEET AND RECONSTRUCTING PIERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., October 25, 1888.

SIR: In compliance with the requirements of section 13 of the last river and harbor act, and letter from office of the Chief of Engineers, dated August 28, 1888, I have the honor to submit the following report of my examination of Saugatuck Harbor, Michigan, made on the 9th instant, with a view "to obtain a channel of navigable width with a minimum depth of 15 feet and reconstructing piers."

A history of the work to the year 1875 is given in the published report of the Chief of Engineers of 1876, Volume II, Part 2, page 508. Previous to Government operations, improvements had been undertaken by interested manufacturers and shippers at a cost of about $30,000, and as a result of this work, a fair class of lake steamers were enabled to enter the river.

The Government undertook the improvement of this harbor by causing a survey of the mouth of the Kalamazoo River (Saugatuck Harbor) to be made in 1867. In 1869 an accurate survey was made and plans and estimates prepared. These were laid before a Board of Engineer Officers, constituted by Special Order, No. 70, Headquarters Corps of Engineers, July 16, 1869. At this time there was at the entrance of the river but 9½ feet of water. The Board contemplated a channel 200 feet wide and 12 feet deep.

Under the project of the Board, work has progressed since as money has been provided, and numerous surveys or soundings have been made from time to time, and at no time has there been found a greater avail-

able depth than 10 to 10½ feet at entrance, and less in the river above to the town.

A Board of Engineers, constituted by Special Order, No. 72, Headquarters Corps of Engineers, May 31, 1875, examined the harbor and concluded, in view of the then declining commerce, that it was doubtful if any work as suggested, viz, to cut a new outlet for the river from Singapore to the lake, was necessary in the interest of navigation.

Again in 1881, upon the recommendation of a Board of Engineers, an elaborate survey of the river and harbor was made by Major Harwood, and plans and estimates were made for the amelioration of the navigation of this river and harbor, and in June, 1882, the Board of Engineers visited the harbor. The views of the Board of Engineers and of the Chief of Engineers are expressed in a letter of instructions to the officer then in charge of the improvement, under date of October 14, 1882, to wit:

In carrying on operations at this harbor you will be governed by the suggestions contained in the closing paragraph of the report (Report of Board of Engineers on Saugatuck Harbor, Michigan, dated Grand Rapids, Mich., June 28, 1882), whether the present depth is not sufficient for the present and prospective commerce, and whether the appropriation should not be applied merely to maintaining the existing condition of the improvement.

Since then no more has been attempted than to maintain the existing work.

The Government has expended upon this work to the present time $134,455.63. The foregoing is given to show that efforts have been made to improve the harbor and river in the interests of navigation and commerce, and that the results attained have not been commensurate with the cost. It is now proposed to improve the harbor to the extent of obtaining a channel of navigable width, with a minimum depth of 15 feet and reconstruct the piers. It is presented in favor of this scheme that—

This harbor has long been neglected, its commerce has increased to an unexpected extent, and it is in the center of the Michigan fruit belt. The channel of the river now is in a most deplorable state; vessels drawing 7 and 8 feet frequently are caught fast upon the bar, and it is almost impossible to do any business by way of the lake. Notwithstanding these disadvantages there are twelve steamers which make regular trips to this port, mostly during the fruit season, and the lake commerce of the town amounts in value to nearly $1,000,000 a year.

About the year 1880 the lumber interests commenced to decline and since that time the fruit industry sprang into existence. It has been discovered that the western part of Michigan is possessed of a climate peculiarly adapted to the raising of all sorts of fruits. The raising of fruit has grown to such an extent that all the farms in that region have been turned into fruit farms; no wheat, corn, or any kind of agricultural products is raised, and the land is cultivated only for the purpose of raising fruit. The result of this has been to create an immense commerce.

Mr. J. F. Henry, president of the village of Saugatuck, has kindly furnished me the following statistics of the port for the year to July 1, 1888:

Daily line of propellers to Chicago and Milwaukee during the fruit season carried 5,000 passengers.

SHIPMENTS.

Lumber, board measurement	feet..	1,000,000
Shingles, A	number..	600,000
Fish	tons..	12½
Veal	carcasses..	639
Lath	number..	100,000
Flour	barrels..	400
Peaches	baskets..	760,000
Chickens	coops...	337
Berries	crates..	1,000

Dried fruit	boxes..	450
Apples	barrels..	13,000
Potatoes	sacks..	1,755
Miscellaneous merchandise	tons..	10

RECEIPTS.

General merchandise	tons..	2,500
Coal	do...	250
Drain tile	do...	100

The Chicago and West Michigan Railway runs north and south, skirting the Michigan fruit belt on the east side, and crosses the Kalamazoo River at Richmond, 9 miles by river from its mouth and 6 miles in a direct line, and a number of railroads enter the region of fruit from the east. Doubtless a much larger proportion of the products of this region would seek transportation by water were a sufficient and constant depth of water maintained in the river and harbor below the town of Saugatuck, and a very much larger production of fruit in this region may be confidently expected in the future, but in my opinion this present fruit business can be readily handled on a less draught of water than 15 feet.

Upon my visit there my attention was called to the prospect of an early construction of an important east and west line of railway having the mouth of the Kalamazoo River as its lake terminus, from which it is proposed to transport coal to the west and receive lumber and iron ore for the eastern markets, and later I received the accompanying letter from Mr. B. C. Faurot, president of the projected road, setting forth the requirements of his road in the matter of terminal lake transportation facilities. Should the projected road be constructed the requirements will necessitate a navigable channel of 15 feet in depth.

My examination was directed to the possibility of making a channel of the required dimensions, and I traversed the routes suggested by Major Harwood for a cut-off from the little lake to Lake Michigan as well as two other routes just to the southward, where depressions indicate an ancient outlet for the waters of the river. The cut-off of the lower loop of the river, estimated by Major Harwood to cost $135,000, appears to me the most ready solution of the problem of improvement here. By it we avoid the shoal places in the river and escape the trouble from drifting sand, which is the main cause of all our difficulty in effecting an improvement here, and the cause of the bar and shoal between the piers.

The first reach of the river beyond the piers runs parallel to the shore of the lake 1,200 to 2,000 feet from it for eight-tenths of a mile and separated therefrom by a loose sand-bank devoid of vegetation. With every westerly wind the sand runs like water into the river, to be carried thence to form the bar and shoals below. Such a cut-off before referred to will effect a very radical improvement, and it would be the plan to pursue in the attempt to obtain 15 feet of water, which would involve a probable expenditure of double the amount of money necessary to obtain a depth of 12 feet.

Considering the present and prospective commerce of the locality, it is my opinion that the harbor of Saugatuck is *not worthy of improvement* by the General Government to the extent of obtaining a channel of navigable width, with a minimum depth of 15 feet, and reconstructing piers.

The present commerce of the port is small and limited to the fruit trade carried on for a brief period of the year only, and any great increase of commerce must result from other than local causes, as the construction of railroads, such as the one proposed from the coal-fields of Ohio to

this point on the lake, for transshipment of ore and lumber between the East and West. It is presumed such a road would follow rather than precede the harbor facilities.

The piers and revetments are in a dilapidated state and are being reconstructed as rapidly as funds permit.

The harbor of Saugatuck is located in the Michigan collection district, Michigan, and is situated at the Kalamazoo Light. The nearest port of entry is Grand Haven, Mich.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF PRESIDENT OF THE LIMA NATIONAL BANK.

LIMA NATIONAL BANK, *Lima, Ohio, October* 20, 1888.

DEAR SIR: Through the kindness of our attorney, J. H. Padgham, of Allegan, Mich., I learn that you have been at Saugatuck, Mich., recently, investigating the surroundings of the same, with a view of making surveys, in the near future, as to the advisability and necessity of constructing, equipping, and maintaining a harbor for the good of the public welfare in general. My object, therefore, in writing you is to fully lay before you, for your careful consideration and investigation (if such is desired), my intense and sincere intentions, which are as follows:

I propose building a railroad from southern Ohio, beginning at the Ohio River, at a point near Plymouth, Ohio; thence in a northwesterly direction to Columbus, Ohio; thence to Marysville, Bellefontaine, Lima, Defiance, and Bryan, all county seats in Ohio; thence to Coldwater, Kalamazoo, Allegan, and Saugatuck, all county seats of Michigan, making a distance of over 400 miles of road, of which I have now obtained four different charters (including a belt railway at Columbus, Ohio) to cover the same, which I propose consolidating into one continuous line. The most of the right of way and local aid has been completed in addition to all the surveys being made, except a portion in Michigan. The first charter in account is the Federal Valley Coal Road, from the Ohio River to Columbus, developing one of the mo t valuable coal and mineral fields in the United States, including iron ore, lime, fire-clay, and building stone, in such abundance that the pen could not possibly describe or make mention of. The building stone is gray, brown, and yellow sandstone, which is now being prominently used in Columbus and other cities; besides timber and fine farming lands, through the noted Scioto Valley. Reaching Columbus we gain an attitude that can not be reached by any other road now entering the city, virtually being master of the railroad situation by controlling the Belt Line, and vast storage grounds, which we have already purchased, in close proximity to the business center of the city, where now thirteen roads already enter; thence we leave Columbus, continuing in a northwesterly direction, reaching Marysville, county seat of Union County; thence to Bellefontaine, county seat of Logan; thence to and through Auglaize County, passing three prominent towns which are isolated from the railway until we reach Lima, county seat of Allen, where the noted Ohio oil fields are; thence through Putnam County, passing several good villages; thence to Defiance, county seat of Defiance County, and thence to Bryan, county seat of Williams, where we intersect the Michigan State line, also passing through other prosperous towns, too numerous to mention; thus passing through the most fertile and productive farming lands, as well as stock lands, in Ohio.

With this we enter the State of Michigan, near the Indiana State line, and continue in a northwesterly direction via Coldwater, Kalamazoo, Allegan, and, finally, reach our terminus at Saugatuck, on Lake Michigan, where we propose making our lake port for distributing coal, coke, and other products to the great Northwest, by steamers, boats, etc.

By carefully consulting the maps you will readily see that we have no competing or parallel lines from Columbus to the lake, and cross more than twenty leading trunk lines in the country, showing the great necessity of all the Ohio towns having direct communication by railroad with their capital as well as with the coal-fields of the south and lumber regions of the north. We also pass the leading towns in Michigan, which are greatly in need of the same—cheap fuel and lumber.

This line also shows a population of over 1,800 to the mile, equally as great in population as any line now built and operated.

I have bought sufficient coal lands in southern Ohio, along our line of road, to supply it in a substantial manner for centuries to come; besides, I have the assur-

ance and guaranty from reliable parties, who are now operating and have already developed sufficient mines to support the road for years to come, and offer almost any inducement to have this road built, as they have millions of dollars invested in their developments, which are now lying idle for the want of shipping facilities to the great Northwest, which all goes to clearly demonstrate the great necessity of such a road, and a sufficiently large and well-equipped harbor at Saugatuck to transport the same across the lakes. We have already negotiations pending regarding the construction of steel boats for carrying on the same, and have, therefore, selected Saugatuck as our port, having ample wharfage and water facilities, and a guaranty of the Saugatuck people that the United States Government would contribute or appropriate sufficient means to construct the harbor of such magnitude as to enable us to carry on a business as the above outlined road demonstrates. Now, had the people at Saugatuck not put such stress upon the Government being willing to aid them or their port, as well as others along the line of shore, provided they procured a railroad, we certainly would not have taken up land at that point or considered any proposition made by them. Further, it will necessitate a good depth of water, as we propose carrying our coal across the lake by heavy steel vessels, without breaking bulk or rehandling same, so the coal that is to reach the Northern Pacific Railway will remain on the original cars at the mines until they reach their final destination. As to the southern Ohio developments, that the millions of dollars that are now invested in mines and in improved property lie idle for want of transportation is unnecessary to make further mention of, as well as the supply to the great Northwest with fuel to relieve them from the yearly coal famines which have been existing for so many years in the past. Should any other information in addition to this letter be desired, or maps, including our geological surveys and report, then please write me and I shall promptly furnish you with the same.

Yours, very truly,

B. C. FAUROT,
President.

Col. S. M. MANSFIELD,
Corps of Engineers, U. S. A.

K K 17.

PRELIMINARY EXAMINATION OF GRAND RIVER, MICHIGAN, FROM GRAND RAPIDS TO LAKE MICHIGAN, FOR CHANNEL OF NAVIGABLE WIDTH, MINIMUM DEPTH OF TEN FEET.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., October 25, 1888.

SIR: In compliance with the requirements of section 13 of the last river and harbor act, and letter from Office of the Chief of Engineers dated August 28, 1888, I have the honor to submit the following report on "Grand River, from Grand Rapids to Lake Michigan, for channel of navigable width, minimum depth of 10 feet."

Grand Rapids, the second city in size and importance in Michigan, is located on both banks of the Grand River, at the head of navigation, and distant 31 miles in an air-line and 40 miles by river from Grand Haven, at the mouth of the river.

A light-draught steam-boat, drawing 30 inches loaded, and plying between Grand Rapids and Grand Haven, constitutes the present commerce of the river. This steamer carries deck loads of supplies and farm produce between the terminal and intermediate points along the river, and occupies two days in making a round trip. During extreme low-water stages the difficulties to navigation are so great as to cause stoppage of this means of transportation.

A deep-water connection with Lake Michigan has long been desired by the citizens of Grand Rapids, and it would undoubtedly prove a great benefit to the varied and extensive manufacturing industries of the city.

At present Grand Rapids is dependent for its transportation requirements upon the railroads which center here from all directions.

Two surveys of Grand River below Grand Rapids have already been made. One in 1880, under the direction of Major Harwood and extending from opposite the city to the tail or lower end of the Ottawa Boom, 34 miles by river below Grand Rapids, and the other in 1884, under the direction of Captain Lockwood, extending from opposite the city to a distance of 11¼ miles below Grand Rapids.

From the maps of these surveys the following facts regarding the physical characteristics of Grand River are obtained:

Below Grand Rapids the river flows with a generally western course, but with many bends and turns. Its banks are varied, being sometimes high and then again low and marshy. The average width of the river at low water is between 400 and 450 feet. The available depth for navigation, owing to numerous bars, is not more than 30 inches. The river bottom consists of sand, gravel, and clay, with occasional bowlders. In the first 12 miles below Grand Rapids, the 6-foot curve is only faintly developed, and the 4-foot curve only over half the distance.

The question of a 10-foot channel was considered by Major Harwood in a report submitted by him under date of February 12, 1881. Two plans were suggested by him, the first being a canal along the river banks, using one bank of the river for one side of the canal and extending from Grand Rapids to the tail of the Ottawa Boom, 34 miles down the river. Speaking of this plan, Major Harwood says:

> A work of this magnitude and extent would cost several millions of dollars, how many to be determined only after a careful survey of each bank of the river to determine the most economical line of direction for the work, followed by a minute and detailed examination of the bank fixed upon throughout its whole extent of 34 miles, with a view to maturing careful estimates for each section of work to be encountered in the way.

The second plan suggested by Major Harwood was to build a canal as before, from the tail of the Ottawa Boom along the river bank as far as Lamont, and then to build an inland canal from Lamont to Grand Rapids, thus shortening the distance by about 7 miles. Speaking of this plan Major Harwood says:

> The gain in distance would be more than counterbalanced by the increase in expense incidental to carrying the canal over the high land between Lamont and Grand Rapids.

In my opinion the river itself is unworthy of improvement with a view to securing a channel of navigable width and depth of 10 feet, for the following reasons:

First. During low stages the volume of water in the river is entirely insufficient to furnish a channel of the desired dimensions by any of the ordinary methods of river regulation, such as training-walls or spur-dikes. Dredging is wholly out of the question. Between 1881 and 1885 $50,000 were expended in dredging to secure a 4-foot channel, and this depth was temporarily secured for a distance of 11¼ miles down the river.

Speaking of these dredging operations Captain Lockwood, in a report by him dated January 29, 1887, says:

> The greater part of the material removed was sand, and I can see no reason for anticipating anything like permanency for the channel, as the main causes that were in operation to maintain the river at its normal depth before the work commenced are active now to restore its bed to its former condition.

Even at this date the benefits of this dredging have disappeared and the river is in its old condition.

Second. A deep-water connection by locks and dams, while practicable, would be very costly, as the banks of the river are not suitable

for this form of improvement, and would involve an extensive system of levees, not only along the banks of the main river, but also along the banks of its tributaries, to protect the adjacent lying farms from being flooded.

A canal outside of the river banks would be far more certain of securing the desired end and would be cheaper.

Captain Lockwood, in his report of January 29, 1887, says:

> In my opinion deep-water connection with Lake Michigan can only be secured by a canal outside of the river banks, using the river as a feeder.

While undoubtedly great benefits would accrue to the large manufacturing interests of Grand Rapids from a deep-water connection with Lake Michigan, any improvement of the river itself with a view of securing a depth of 10 feet is not justified on account of its expense, and I concur in the opinion expressed by Captain Lockwood that a canal outside the river banks will furnish the true solution of the problem. In this connection it might be well to state that in my opinion a depth of 10 feet will not meet the requirements of Grand Rapids.

If the lake commerce is to be brought to the doors of Grand Rapids through the medium of a water route, nothing less than a 14-foot channel should be thought of. A depth of 10 feet is insufficient for the class of vessels now navigating the lakes, and the tendency is to increase their present draught, so that 14 feet would not be any too much.

No further survey is needed, as the surveys of Major Harwood and Captain Lockwood supply all necessary data. The following statistics regarding the industries of Grand Rapids were kindly furnished me by the Grand Rapids Board of Trade, and are for the year 1887.

The report shows that there were 380 factories employing 11,110 operatives, with a capital employed of $15,216,400, the product amounting to $24,048,800.

Among the leading industries are:

Number.	Kind of factory.	Employés.	Capital employed.	Product for 1887.	Number.	Kind of factory.	Employés.	Capital employed.	Product for 1887.
2	Agricultural implements	29	$50,000	$200,000	3	Flavoring extracts	23	$45,000	$145,000
2	Burial caskets	66	78,000	125,000	6	Flour-mills	77	568,000	1,360,000
1	Brush	115	100,000	100,000	3	Furniture wood trimmings	81	150,000	110,000
3	Bent wood	34	35,000	60,000	1	Fire-grate	54	60,000	175,000
5	Brick and tile	167	155,000	805,000	28	Furniture	4,662	3,723,000	5,941,000
7	Breweries	130	400,000	600,000	1	Glue	10	25,000	25,000
6	Bottling	32	40,000	118,000	1	Gas	30	250,000	130,000
2	Belting	44	65,000	230,000	8	Harness	29	26,000	78,000
12	Barrel and keg	286	372,000	510,000	37	Lumber and planing	684	3,861,000	4,586,000
2	Boot and shoe	193	350,000	685,000	1	Middling-purifier	23	25,000	50,000
17	Boiler and machine	503	481,000	706,000	3	Packing-boxes	60	30,000	143,000
1	Curtain-pole	41	28,000	48,000	1	Piano	101	85,000	125,000
1	Car-shop	325	200,000	425,000	5	Plaster-mills	127	750,000	200,000
2	Cracker	45	145,000	185,000	1	Pump	4	25,000	6,500
14	Carriage and wagon	425	482,500	787,500	1	Refrigerator	81	75,000	100,000
5	Clothing	138	100,000	200,000	6	Sash, door, and blinds	91	145,000	215,000
29	Cigar	136	205,000	376,000	3	Soap	17	35,000	63,000
1	Carpet-sweeper	211	150,000	300,000	1	Tub and pail	263	250,000	250,000
9	Confectioners	175	125,000	432,000	3	Tanneries	316	415,000	1,030,000
2	Electric motors	7	50,000	75,000	5	Upholstering	54	49,000	161,000
4	Excelsior	58	57,000	110,000	4	Wall coating compound	78	200,000	250,000
2	Electric light	35	250,000	250,000					

Grand Rapids is a port of entry. The nearest light house is at Grand Haven, Mich.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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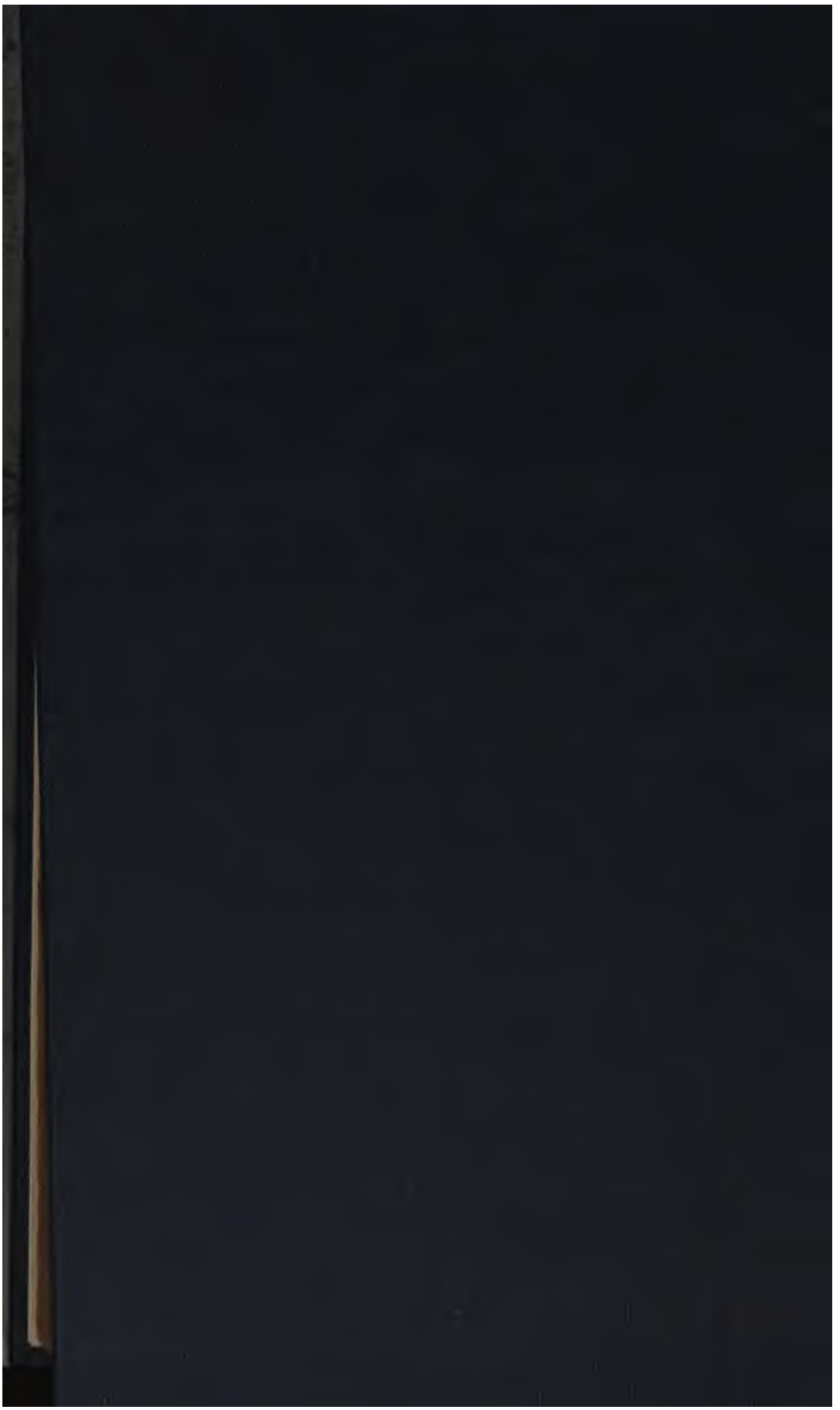
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